DISSERTATION ON

CORRELATION OF RETINAL NERVE FIBRE LAYER THICKNESS IN OPTICAL COHERENCE TOMOGRAPHY WITH VISUAL OUTCOME IN OPTIC NEURITIS

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CERTIFICATE

This is to certify that this dissertation entitled "**CORRELATION OF RETINAL NERVE FIBRE LAYER THICKNESS IN OPTICAL COHERENCE TOMOGRAPHY WITH VISUAL OUTCOME IN OPTIC NEURITIS"** is a bonafide record of the research work done by **Dr. C.USHA**, post graduate in Regional Institute of Ophthalmology and Government Ophthalmic Hospital, Madras Medical College and Government General Hospital, Chennai-03, in partial fulfillment of the regulations laid down by The Tamil Nadu Dr. M.G.R. Medical University for the award of M.S. Ophthalmology Branch III, under my guidance and supervision during the academic years 2013 - 2015.

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I hereby declare that this dissertation entitled, **"STUDY ON CORRELATION OF RETINAL NERVE FIBRE LAYER THICKNESS IN OPTICAL COHERENCE TOMOGRAPHY WITH VISUAL OUTCOME IN OPTIC NEURITIS"** is a bonafide and genuine research work conducted by me under the guidance of **Prof. Dr. K. NAMITHA BHUWANESWARI, M.S.,** Professor Department of Cornea, Regional Institute of Ophthalmology, Government Ophthalmic Hospital, Chennai - 600 008.

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ABBREVIATION

ONTT	-	Optic Neuritis treatment trial
MRI	-	Magnetic resonance imaging
RB Neuritis	-	Retrobulbar Neuritis
CSF	-	Cerebrospinal fluid
OCT	-	Optical coherence tomography
RNFL	-	Retinal Nerve Fibre Layer
OCT, SLO	-	OCT-scanning laser ophthalmoscopy
ICM	-	Internal Limiting membrane
RAPD	-	Relative afferent Pupillary defect
SA SPACE	-	Sub Arachnoid Space
VEP	-	Visually evoked potential
HIV	-	Human Immuno Defeciency virus
VDRL	-	Venereal Disease Research Laboratory
MMR	-	Mumps, Measles, Rubella
SLE	-	Systemic Lupus Erythematosus
PAN	-	Poly Arteritis Nodosa
ONH	-	Optic Nerve Head
PL	-	Perception of Light
AION	-	Anterior Ischemic Optic Neuropathy

MS	-	Multiple Sclerosis
FB	-	Foreign Body
VZ	-	Varicella Zoster
TB	-	Tuberculosis
DM	-	Diabetes Mellitus
FFA	-	Fundus Fluorescein Angiography
RPE	-	Retinal Pigment Epithelium
HRT	-	Heidelberg Retinal Tomography

CONTENTS

INTRODUCTION

Optic neuritis is an inflammation of optic nerve. The annual incidence is 1-5/1,00,000. It can occur as unilateral or bilateral disease, usually bilateral in pediatric population.

Optic neuritis affects females more commonly than males. Majority will present in 20-50 years group, mean age is 30-50 years, but it can occur in any age group.

Patients present with painful visual loss of acute onset associated with field defect. Visual acuity ranges from 20/20 to no perception of light.

On examination there will be relative afferent pupillary defect in almost all cases, the exception being bilateral disease or the fellow eye with optic atrophy, and defective colour and contrast sensitivity .The contrast sensitivity will at times be worse than the visual acuity.

Examination of fundus will reveal disc edema with blurring of margin and hyperemia, but the disc will appear normal in retrobulbar neuritis .

Unilateral or bilateral optic neuritis and myelitis in Devic's syndrome.Common field defect in optic neuritis is central or centrocecal scotoma, but other defects like arcuate and altitudional (ONTT study) can occur. The common causes for optic neuritis are idiopathic and demyelination.

Investigations like MRI (to look for demyelination), blood investigation and x-ray sinuses (to rule out septic foci), and x-ray chest(to exclude sarcoidosis), MRI spine and NMO-IgG (Neuromyelitis optica), CSF analysis(Multiple sclerosis and Neuromyelitis optica) are done in cases of optic neuritis.

Patients of optic neuritis are treated with intravenous methyl prednisolone 250mg four times a day for three days

followed by oral prednisolone 1mg per kg body weight for 11 days(according to ONTT study), this speeds up the recovery and prevents relapse of disease.

Optical coherence tomography is a new tool in optic neuritis to quantify axonal loss after optic neuritis, hence can be used to assess visual outcome in these patients**.** OCT utilizes infrared light of 800-820nm light.

It utilizes Michelson interferometry to produce cross sectional images based on optical scattering of light. 3.4mm circular scan centered around the disc measures the nerve fiber layer thickness(RNFL scan) and compares the thickness with age adjusted normative data. Other protocols available for evaluation of retina are macular scan and optic disc analysis.

RNFL scans are useful to assess the progressive changes and to correlate with visual outcome and visual field defects.

There is thinning of RNFL in optic neuritis after an attack. With the thinning , visual recovery and the chances of going for optic atrophy can be predicted. In our study spectral domain OCT-SLO is used to quantify RNFL thickness. Hence OCT can be used as a diagnostic tool in optic neuritis.

ANATOMY OF OPTIC NERVE

It is second cranial nerve extends from optic disc upto optic chiasma where the two nerves meet each other. It is nothing but the continuation of nerve fiber layer of retina. It is comparable to a sensory tract of the brain morphologically and embryologically. Because it is an outgrowth of the brain it is surrounded by meninges and like other nerves it is not covered by neurilemma.

Optic nerve is divided into 4 parts they are intraocular (1mm) intraorbital (30mm) intracanaliculer (6–9 mm) intracranial (10m).

Intraocular part appears in the eyes as optic disc and has an average diameter of 1.5mm which expands to 3mm just behind the sclera, where it acquires myelin sheath.

I. Intraocular Part:

The optic nerve head is divided into 4 portions. Surface nerve fiber layer : It is essentially composed of axonal bundles and covered by astrocytes, ILM of elschnig which separates it from vitreous. Figure -1 describes the relations of optic nerve to ocular structures.

Pre laminar region : composed of neurons and astroglial tissue separated from choroid by a cuff of astrocytes.

Lamina cribrosa: It is made up of fenestrated sheets of scleral tissue lined by glial

tissue. Bundles of optic nerve leave the eye through this. The lamina cribrosa gets its blood supply from circle of zinn.

Retro laminar region: Here the nerve gets its myelin sheath so become thicker.

II. Intra orbital Part:

This parts extends from back of the eyeball to the optic foramina and it is sinous to play for the eye movements. It is covered by dura, arachnoid and pia. The central retinal artery with vein crosses in SA space to enter the nerve on its infero medial aspect. Posteriorly the nerve is closely surrounded by annulus of Zinn and origin of 4 recti muscles. Some of superior rectus and medial rectus are adherent to its sheath.

The long and short ciliary nerves and arteries surround the nerve. Ophthalmic .A, superior Ophthalmic.V, and nasociliary nerve cross superiorly from lateral to medial side of the nerve.

Ciliary ganglion, Branches of oculomotor nerve, nasociliary nerve, sympathetic and Abducent nerve, are situated in between the nerve and lateral rectus muscle.

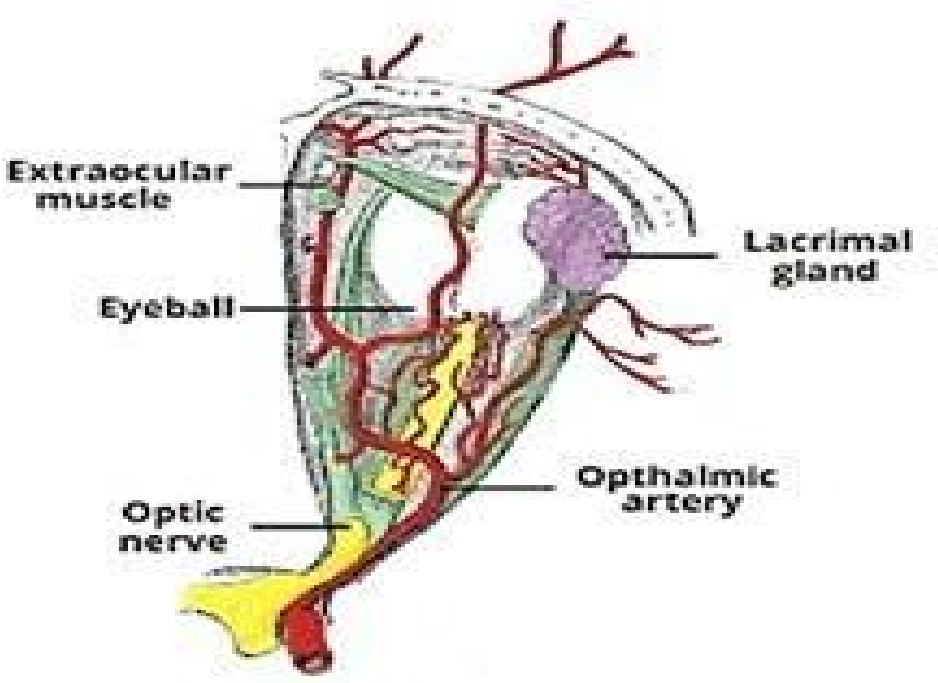
III. Intra canalicular Part:

Ophthalmic A is closely related and crosses the nerve from medial to lateral side inferiorly sphenoid and posterior ethmoidal sinuses lie medial to it and separated only by a thin bone. Hence there are chances of RB neuritis (Retrobulbar neuritis) following sinusitis.

IV. Intracranial part:

This lie above cavernous sinus and converge to form the optic chiasma. The internal carotid.A runs below and the lateral to it. Olfactory tract and anterior cerebral A lie above this.

Figure 1-Optic nerve in relation to ocular structures



Arrangements of nerve fibers in optic nerve:

In nerve head it is same as in retina, behind the eye the upper and lower temporal half are separated by papillomacular bundle situated on temporal side. The upper and lower nasal fibers are situated on nasal side, near chiasma the macular fibers are centrally placed.

Blood supply of optic nerve:

I. The intraocular parts

The surface nerve fibre layer is supplied by capillaries of retinal vessels. The prelaminar region by vessels of ciliary region. The Laminacribrosa region by the short posterior ciliary arteries and circle of Zinn –Haller. The retrolaminar region by ciliary (from recurrent pial vessels) and retinalcirculation. The central retinal. A provides centripetal branches from pial plexus and also centrifugal branches. Figure-2 depicts the blood supply of optic nerve.

II. Intra Orbital Part- Supplied by 2 system

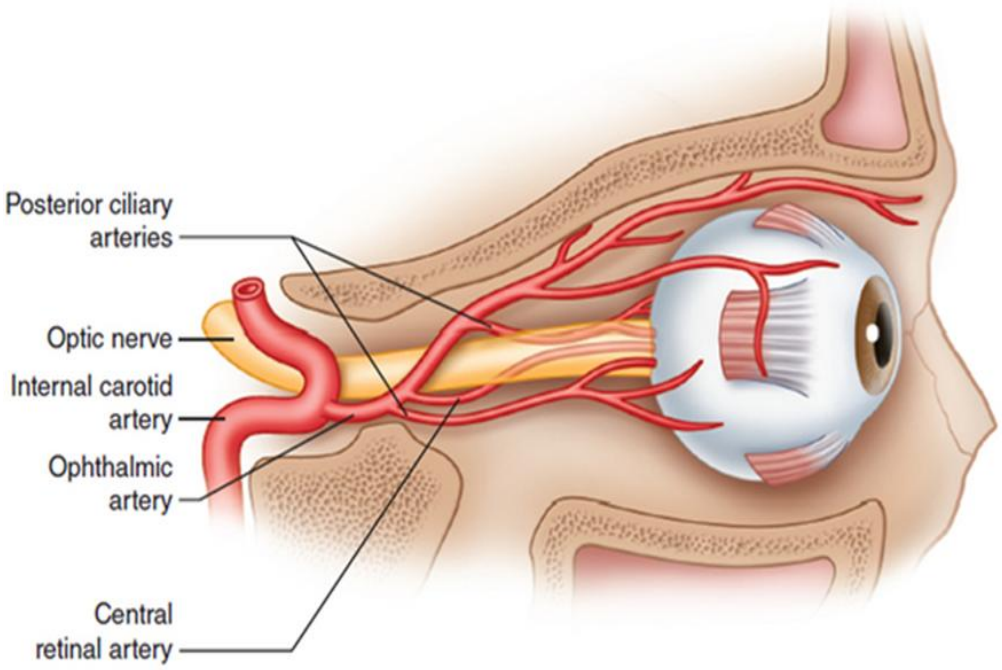
A periaxial system is derived from 6 branches of ICA namely ophthalmic. A, long and short posterior citiary. A, Lacrimal.A, Central retinal A, Circle of Zinn.

The axial system is derived from the intraneural branches of central retinal.A, central collateral arteries from CRA, and central artery of optic nerve.

III. **Intracanalicular part** is supplied by periaxial system of vessels.

IV. **Intracranial part** is exclusively supplied by periaxial system of vessels.

Figure 2-Blood supply of optic nerve



Venous drainage

- From optic nerve head venous drainage is by the central retinal.V .

- The orbital part in its proximal end drained by pial plexus and distal end by central retinal.V.

- The intracranial part is drained by the pial plexus which ends in anterior cerebral and basal vein.

OPTIC NERVE PHYSIOLOGY

There are two system of retinal ganglion cells- P cell system and M cell system.

P cell system - 80-90% of these cells are of small to moderate size and they are concentrated in macula and projects into the parvocellular layer of lateral geniculate ganglion. They thought to subserve high contrast high spatial frequency resolution.

M cell (Large cells) system is fast conducting and comprise about 10-20% of ganglion cell population. M cells project into magnocellular layer of lateral geniculate ganglion. They are involved with non colour information.

TOPOGRAPHIC ANATOMY OF OPTIC NERVE

Peripheral ganglion cells occupy the periphery of optic disc and the central portion of the disc is occupied by ganglion cells located closer to optic disc.

The arrangement of fibers in the disc and distal portion of nerve corresponds to topographic distribution in retina. The papillomacular bundle occupies temporal optic disc and these fibers moves centrally in the distal portion of optic nerve. All retinal fibers retain their position throughout the visual pathway. Because some axons decussate in optic chiasma the axons lose their retinotopic order to some extent.

Hence retinal disease is divided into 1.those affecting the detection apparatus and 2.those affecting the conducting apparatus.

Retinal diseases have to be differentiated from macular diseases by the following ways:

Features	Optic nerve disease	Macular disease
Metamorphopsia	Absent	Present
Pain on eye movements	Present	Absent
Relative afferent pupillary defect	Present	Absent
Colour vision	Markedly reduced	Slightly reduced
Contrast sensitivity	Markedly reduced	Variable
Amsler grid	Scotoma	Metamorphopsia

OPTIC NEURITIS

INTRODUCTION :

Optic neuritis is an inflammation of one or both optic nerves resulting in temporary visual loss. Affects young to middle aged adults between 20 to 50 years of age, with a mean age of 30-35. But it can affect individuals of any age. Children are affected bilaterally whereas in adults it is usually unilateral. Butin adults bilateral disease can occur in patients of multiple sclerosis. The female to male ratio is 3:1 and the incidence is 1-5/1,00,000.

Apart from idiopathic variety two variants of optic neuritis are optic perineuritis and neuroretinitis. In optic perineuritis there will be involvement of optic nerve sheath without involvement of optic nerve. Neuroretinitis is involvement of retina along with optic nerve.

SYMPTOMS :

Patient of optic neuritis will present with:

Loss of central vision (in more than 90%).

Loss of peripheral vision in superior or inferior fields associated with orbital pain(90%) above or behind the eye .

Visual acuity decreases over next several days from 20/20 to no perception of light .

There will be loss of colour vision and perception of phosphenes (less common symptom)(30%).

There will be reduced contrast sensitivity in all cases.

After an attack of optic neuritis even after complete recovery of vision some patient may complain of transient loss of vision with over heating or exercise(uhthoff symptom).

SIGNS :

1. Visual acuity ranges from 20/20 to no PL .

2. Visual field defects – central scotoma , centrocecal scotoma, arcuate scotoma, superior or inferior altitudinal scotoma , Bi temporal or left or right hemianopia . Any type of field defect can occur but in ONTT study with automated perimetry of central 30°, the field revealed diffuse loss in 48% and focal loss is 52%.

3. Reduced contrast sensitivity and colour vision . The loss of contrast sensitivity is proportionate to or sometimes worse than loss of visual activity. The colour dysfunction is more severe than visual activity level. In ONTT, no particular type of colour vision defect was consistently associated with optic neuritis .

4. Relative afferent pupillary defect is always present in optic neuritis, unless it is bilateral or the fellow eye with optic

atrophy. It is diagnosed by swinging lash light test . By swinging the flash light the amplitude and thevelocity of pupillary constriction are compared with other eye and it should be equal when there is no RAPD.

5. Fundus findings – Disc edema with minimal blood vessel enlargement and rarely peripapillary hemorrage in papillitis . Normal appearing fundus is retrobulbar neuritis . After 4-6 weeks the disc becomes pale .

Figure 3-Showing disc changes in optic neuritis

Figure-3 shows the fundus changes in optic neuritis. Papillitis is shown with disc edema and in retro bulbar neuritis there is no disc edema.

DIFFERENTIAL DIAGNOSIS OF OPTIC NEURITIS

1. Acute ischemic optic neuropathy – Painless visual loss , associated with usually altitudional field defects . In fundus more papillary hemorrhage with sectoral disc edema of pallid type will be seen. It is the disease of elderly above 50 years . It can be anterior or posterior depending upon the location of ischemic damage, and it can be arteritic or non arteritic depending on etiology.

   Arteritic AION is usually associated with giant cell arteritis and other connective tissue disorder. Non arteritic ischemic optic neuropathy in majority is due to idiopathic and ischemia due to causes other than arteritis.

2. Leber's hereditary optic neuropathy – Patients are usually males of 15 to 35 years and present with painless loss of vision in one eye followed by other eye. Fundus findings are circum papillary telangiectatic microangiopathy, swelling of nerve fibrelayer around the disc. Genetic

testing shows DNA(mitochondrial) mutations. Corticosteroids is of no use here in leber's optic neuropathy.

3. Vogt koyonagi harada disease – hyperaemia of optic disc and optic neuritis in addition to uveitis, choroiditis and exudative retinal detachments are seen .

INVESTIGATIONS

Diagnostics studies are performed to rule out some other lesions like compressive lesion for optic neuropathy, to determine other than demyelination causes responsible for inflammation of nerve and to determine the visual and neurological prognosis of optic neuritis .

MRI brain is not for the diagnosis of optic neuropathy but best in recurrent opticneuritis and is assessing the progression of MS. 40-70% of patients with isolated optic neuritis will have periventricular white matter signal abnormality on T-2weighted

images. Diffuse enlargement of optic nerve will be seen on fat suppressed scan with or without contrast enhancement. Gadolinium enhancement will show inflammatory infiltrate and expansion of extra cellular space. MRI brain and optic nerve is done usually. MRI is indicated in diagnosing optic neuritis in patients above 45 years, in bilateral cases, in cases of optic neuritis which shows progression beyond 2wks and in patients of optic neuritis with atypical fields like hemianopic defects.

MRI is contra indicated in patients with ferromagnetic implants, FB, cardiac pace makers, metallic cardiac valves and in claustrophobia.

VEP (Visually evoked potential) -In visually asymptomatic or suspected or known MS patients VEP seems to bea sensitive indicator .It is helpful in predicting the progression of MS. VEP is the measurement of signal in occipital cortex in response to light stimulus, damage anywhere along the afferent pathway will produce abnormality. It contains N1(negative peak) then

P1(positive peak) followed by second negative(N2) and positive(P2). Positive peak is usually at 100 msec.

Latency and amplitude are analysed and compared with the other eye Demyelination will produce increased P-100 latency without affecting the amplitude. Multifocal VEP can detect small abnormalities of transmission in optic neuritis. In toxic, ischemic and compressive lesions the amplitude will get affected first.

Chest x ray , HIV,VDRL, X-ray of sinuses , blood routine are important to exclude other causes of optic neuritis .

CSF analysis is important in patients with abnormal MRI suggestive of MS to look for oligoclonal bands, anti MBP and anti PLP antibodies.

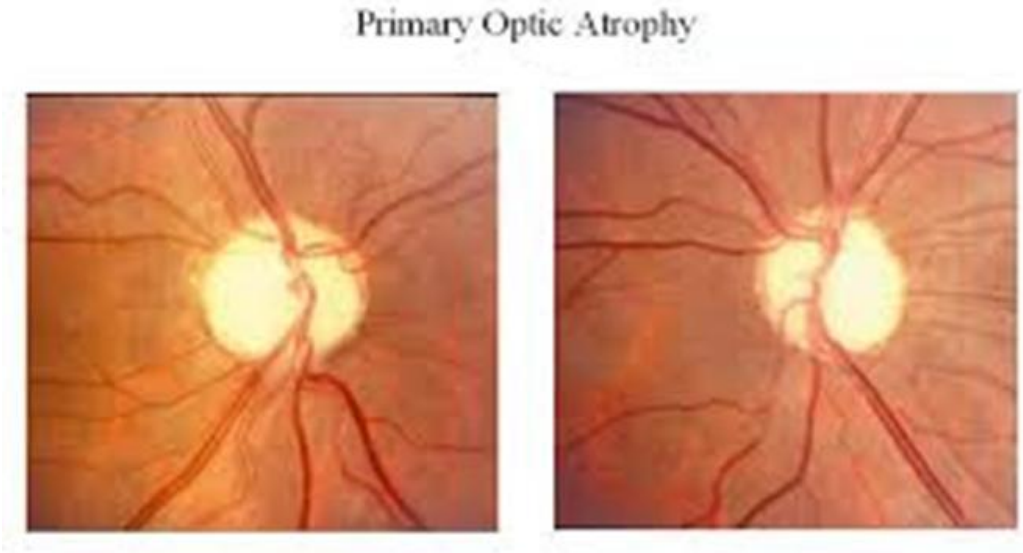
PROGNOSIS

Complete visual , field , colour vision, contrast sensitivity recovery by 5 weeks after onset . Recurrence rate is 35% according to ONTT . The risk of recurrence increases(41%) in those treated by only oral steroids.Optic neuritis occurs in 50% as initial presentation in patients with MS and the risk of developing MS after optic neuritis in 5 years is 30% .

RESIDUAL DEFICITS AFTER OPTIC NEURITIS

Disc pallor, RAPD,Colour vision defects and prolonged latency in VEP.ONTT showed 30% of contrast sensitivity,55% of colour vision was normal after recovery and 58% showed no significant field abnormality.

Figure 4-Shows pale disc in optic atrophy



TREATMENT

As per ONTT guidelines patients after acute optic neuritis are treated with 250 mg methyl prednisolone four times daily for 3 days and followed by oral prednisolone of 1 mg/kg/day for 11 days. Long term treatment with interferon beta- 1a should be considered in high risk patients .

OTHER DEMYELINATING CONDITIONS ASSOCIATED WITH OPTIC NEURITIS

Devic's disease

Devics disease occurs in children and young adults of both sexes represents <1% of demyelinating diseases . Here the brain , spinal cord and optic nerves are affected . Patient presents with bilateral visual loss and paraplegia. In devic's disease cerebellum will never get affected, excavation leading to cavity formation will be there and there will be no gliosis are all in contrast to multiple sclerosis. Loss in vision is rapid and severe in Devic'

disease. There is disc edema in fundus examination and most of them develop disc pallor. The mortality is 50% in thesepatients.

Diagnosis is by CSF analysis ,MRI , NMO-IgG(50%)in serum and it is treated with corticosteroids .

Schilder's Disease

Patients will present with visual loss due to damage of post chiasmal damage to visual pathway. There will be homonymous hemianopic and quadrantic defects or cerebral blindness. MRI shows demyelination with CSF changes similar to MS. It is progressive and lethal to life, death can occur within months.

Causes of optic neuritis are mainly demyelinating and idiopathic .

Other causes are:

1. Optic neuritis in other primary demyelinating diseases like devics disease and schilder's disease .

2. Infectious end para infectious optic neuritis – following viral infection in children due to immune medicated demyelination – adenovirus, coxsakie virus, CMV, HIV, measles, mumps,VZ,rubella and Hepatitis A viruses.Bacterial causes include syphilis , lymes disease, catscratch disease, anthrax,B haemolytic streptococcal infection , brucellosis, meningococcal infection , TB , and typhoid disease . Aspergillus and mucor infection of sinuses in DM patients can involve optic nerve .

3. Post vaccination optic neuritis – Both retrobulbar and papillitis can occur. Usually occur 1-3 weeks after vaccination. It can occur with BCG, Hepatitis-B, Rabies vaccine, Tetanous toxoid, and MMR (Mumps,measles and rubella)

4. Inflammatory optic neuritis – in sarcoidosis, SLE, PAN, and other vasculitis. These can present as retrobulbar

neuritis or anterior optic neuritis. Disc is lumpy white in sarcoidosis with inflammatory reaction in vitreous.

5. Auto immune optic neuropathy . Patients usually will present with recurrent episode of visual loss with good response to steroids.

OPTIC PERINEURITIS

It is due to inflammation of nerve sheath without involvement of the nerve proper. There is bilateral disc edema similar to papilledema. This is not associated with MS. In most cases there is an associated infectious process.

NEURORETINITIS

Patients will present with unilateral visual loss without pain and usually occurs in third or fourth decade. RAPD will be present. Common field defects here are centerocecal,central scotoma but arcuate and altitudinal defects can occur. There will be disc edema with surrounding hemorrhages with macular star

like exudates. Small white discrete chorioretinal lesions may be seen associated with inflammation of vitreous. It is a self-limited condition with good visual prognosis. It is due to infectious or para infectious diseases.FFA(Fundus fluorescein angiography) will show swelling of disc and leakage from vessels on the disc. MS is not associated with this and it can occur in some systemic inflammatory disorders like sarcoidosis and in infectious diseases like cat-scratch disease. It can be caused by infections like syphilis, lyme's disease and leptospirosis.Treatment depends on the cause.

OPTICAL COHERENCE TOMOGRAPHY (OCT)

It allows non invasive cross sectional imaging of living tissue. It works through low coherence interferometry. It utilizes 800-820nm infra red light from super luminescent diode and is projected on the retina.It has an axial resolution of 8μm to 3 μm . The exiting light is split into 2 , with one beam entering the eye and the other to a reference mirror, if the path length of the two arms is closely matched to within the coherence length, an interference signal is detected and translated into two dimensional colour coded representation of retinal layers . The operator view in real time an infrared video image of fundus displayed as the computer to ensure proper alignment . The patient view a fixation light . By scanning the mirror in reference arm reflectivity profile is obtained and it is called Ascan which has information on spatial dimension and location of structures. Cross sectional tomographic B scan is obtained by combining the a scans.

A sequence of axial scans at various transverse positions is obtained to form two dimensional representation of retina . The ability to image the morphology and any abnormalities is based upon the fact that biologic tissues of differing densities have different back scattering properties .

OCT representation of normal retina:

- OCT allows retina to be studied in terms of cross sections of vitreous,from ILM to choriocapillaries and superficial choroidal layers.
- Due to the contrast between the nonreflective vitreous and reflective retina the ILM is clearly defined.
- RNFL is more visible in areas of papillomacular bundle because of its density.
- Reflectivity is greater in plexiform than that of nuclear layer.
- Retinal vessels are not clearly seen.

- Photo receptors because of its vertical orientation, forms a poorly reflective band in front of RPE.
- Retinal pigment layer is highly reflective.

In normal retinal scans the interface between the posterior hyaloid and the internal limiting membrane can only be visualized if hyaloid is elevated off the surface of the retina , the fovea is displayed with its normal thinning due to the absence of inner retinal layers . A false colour coding system is used , those with high reflectivity like RNFL and RPE are represented in red colour and medium reflectivity are with yellow or green and low reflectivity are represented by black colour . A colour coded map along with a legend is displayed in order to facilitate rapid interpretation of numerical values.

Greater thickness is represented by hot colours like red and white, average thickness by green and thin areas by cooler colours like blue or black .The standard deviation of centre point is determined by comparing the six points which cross through

the centre in the scanning protocol and is recorded with the centre point .

Image processing algorithms allow automated measurements of retinal thickness. This is accomplished by determining the anterior and posterior surfaces of retina . The anterior surface is defined by transition from the low reflectivity of vitreous cavity to the high reflectivity of nerve fibre layer. The posterior surface is defined by high reflectivity of the junction between retinal tissue and RPE/chorio capillaries complex .

RNFL scanning involves a circular 3.4mm diameters centred in optic nerve heads which then displayed as cross sectional image.Characteristic changes in reflectivity at inner and outer retinal boundaries are converted into RNFL thickness data by computer algorithm . The data is then divided into and displayed in superior, inferior, nasal and temporal quadrants as well as 12 clock hours sections of 30 degrees each .

The boundary of ONH is defined by the termination of RPE , thus minimising the need for the user to identify the disc margin . The machine is able to scan the macula rising 6 equally spaced linear scan .

The OCT scan of retina allows cross sectional study of macular ,peripapillary region including RNFL and optic nerve head region .

Figure -5 shows the principle of OCT.

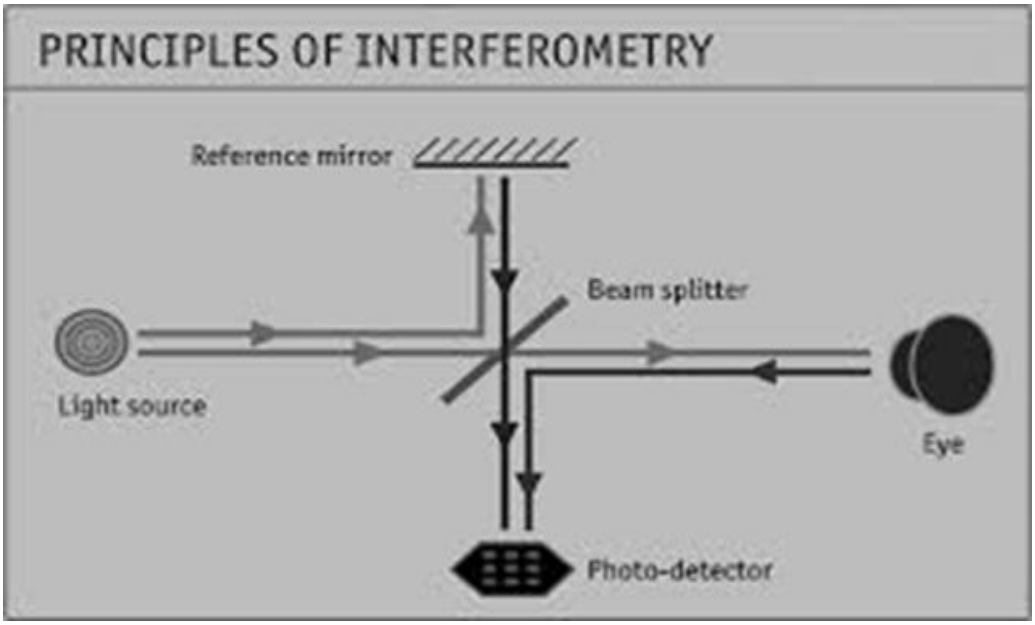
Types of OCT:

1. Time domain OCT- Here the interference is achieved when the pathdifference is within the coherence length of light source.It has a resolution of 8-10 microns. 400 A sans per second can be obtained.

2. Frequency domain OCT- For interference spectrally separated detectors are used. Two types available, they are:

- Spectral domain OCT- Here by distributing different optical frequency on detector stripe a spectral information is extracted. The resolution is 5-2 microns in tissues. 20,000-52000 A scans can be obtained per seconds.
- Time domain OCT-Here the spectral component is encoded in time.

Figure 5 -shows the principle of OCT



In SD-OCT the moving part which is present in conventional instrument is replaced with spectrometer and this captures scans quikly before the patient their gaze. Faster speed, high resolution and improved signal to noise ratio improve the detection of true boundary of outer retina and enable the detection and quantification of clinically relevant disease features. In 3-D OCT C-sans are produced from B-scans to produce three dimensional images. Various types of 3-D OCT available are:1.TOPCON 3-D OCT 1000, 2.OTI-OCT SLO, 3.OPTOVUE- RTVUE 100, 4.OPTOPOL-SOCT COPERNICUS.

The following table compares the features of different OCTs

FEATURES	CONVENTIONAL OCT	UHR OCT	3 D- OCT
Measurement principle	Time domain	Timedomain	Spectral domain
Light source	Super luminescent diode laser	Femtosecond sapphire laser	Super luminescent diode laser
Measurement capabilities	A scan B scan	A scan B scan	A scan B scan C scan
Wave length	820 nm	815 nm	840nm
Band width	25	125	50
Axial resolution	10 microns	3 microns	5microns
Transverse resolution	20 microns	15-20 microns	<20 microns
Dilatation of pupil	Required	Required	Not required
Scanning speed	1.3 seconds	4 seconds	0-0.5 seconds
Macular scan	6 radial scans	6 radial scans	Raster scans

OCT-SLO

Optical coherence tomography – scanning laser ophthalmoscope is a new imaging modality, that combines the abilities of SLO&OCT .With this OCT B-scan images and simultaneous SLO pixel images is created for precise OCT image localization. B scan images are created by x-y scanning at increasing depths and also permits accumulation of information from entire planes of tissue at varying depths thus creating c-scans. It uses beam splitter to create two channels, one uses SLO to create red free images the o. It uses beam splitter to create two channels, one uses SLO to create red free images and the other is used to create OCT images. With this instrument precise anatomic localization of OCT images is possible.

RNFL thickness is super imposed against a normative database graph with green is considered within normal limits and red outside normallimits.The mean 360 degree average values of

healthy peripapillary RNFL thickness range between 89.8 and 113.38 microns.

Several studies showed progressive thinning of RNFL with increasing age by OCT. A decline of 2µm per decade in the mean RNFL thickness.

RNFL thickness decreased by 2.2µm for every 1mm increases in axial length and it is decreased by 0.9µm for every 1 diopter change in spherical equivalent power towards high myopia .

Benefits of OCT are :

1. Creates live sub surface images at near microscopic resolution.
2. Obtains instant and direct imaging of tissues.
3. With this OCT no preparation of sample or subject is required.
4. There is no risk of ionizing radiation.

Despite normal visual recovery there is loss of nerve fibre in the form of thinning of RNFL in cases of fully recovered optic neuritis in OCT . In case of MS, OCT has found thinning of nerve fibre layer even without an episode of optic neuritis. deseze et al found that RNFL thinning was more pronounced in neuromyelitis optical and controls and this corresponds with the worse visual prognosis .

REVIEW OF LITERATURE

1. A Review on optic neuritis by the National Hospital for Neurology & Neurosurgery, London, and Moorfields Eye Hospital, London,and St Thomas Hospital, London. They found that low contrast acuity and contrast sensitivity have high correlation with structural changes like RNFL thickness measured by optical coherence tomography, linking visual function with structural derangements.

2. Andrew P. D. Henderson et al had done a serial study on retinal changes following optic neuritis for neuroprotection trial. Found in Brain(2010) 133(9):2592-2602.All cases of clinically isolated unilateral optic neuritis were made to undergo optical coherence tomography, visual assessments and visual evoked potentials at presentation (median 16 days from onset of visual loss) and after 3, 6, 12 and 18 month. The retinal nerve fibre layer thickness of the affected eye was significantly increased at presentation and

significantly reduced at all later time points when compared with the unaffected eye. They found that thinning appears at around 1.6 months from the onset of symptom and further loss thereafter.

3. Fiona Costello et al studied about sex differences in RNFL thinning after acute optic neuritis. In this study men were older than women and 62% of men had relapsing MS. They found that after 6 months mean retinal nerve fibre layer values were lower(74 μm) in men than women(91 μm)

4. R. T. Naismith, MD et al in Neurology March 24, 2009 vol. 72, 1077-1082 done study on OCT findings and found that they differ in neuromyelitis optica from MS. Neuromyelitis optica (NMO) is associated with destructive inflammation, resulting in necrosis and axonal injury. Disability from multiple sclerosis (MS) is due to a combination of demyelination and varying axonal

involvement. Optical coherence tomography (OCT), by measuring retinal nerve fiber layer (RNFL) as a surrogate of axonal injury, has potential to discriminate between these two conditions.

5. Brain (2012) 135 (2): 521-533. Optical coherence tomography segmentation reveals ganglion cell layer pathology after optic neuritis. Thinning was observed in the ganglion cell layer of eyes of acute optic neuritis 3 and 6 months after onset ($P < 0.001$). Peripapillary RNFL oedema was observed in affected eyes ($P = 0.008$) and subsequently thinned over the course of this study. Ganglion cell layer thickness was lower in both participants with multiple sclerosis and participants with neuromyelitis optica, with and without a history of optic neuritis, when compared with healthy controls ($P < 0.001$) and correlated with visual function.

6. Costello F et al done a study on quantification of axonal loss with OCT in optic neuritis, I t is found in Ann neurol 2006 jun ;59(6):963-9.In this study they correlated visual acuity with degree of changes in retinal nerve fibre layer thickness. Here 54 patients after optic neuritis underwent repeated evaluation of RNFL with OCT and Regression analyses were used to determine the relationship between RNFL thickness and visual function. They found thinning of RNFL in 74% and they also found that it occur within 3 to 6 months of ON. The average RNFL value was thinnerwas ($p<0.0001$) in the affected (78 micron) compared with the unaffected eye (100 micron). Regression analyses demonstrated a threshold of 75 micron, below which there is persistent visual dysfunction. More thinning noted in patients with impaired visual function.

7. Dr. M. Kolappan, A. P. D.et al in journal of neurology march 2009,vol 256,issue 3,305-319 said that there is retinal nerve fibre layer thinning in patients after an attack of optic neuritis. Confocal scanning laser ophthalmoscope, scanning laser polarimetry, optical coherence tomography can be used to quantify RNFL thickness. MRI is of value in atypical cases but not in routine cases.

8. Ahn HC et al done a study on quantitative analysis of retinal nerve fibre layer in normal children and adolescents by OCT. It is there in Korean j ophthalmol, 2005 sep;19(3): 195-200. In this study 144 eyes of 72 normal children and adolescents were analysed with OCT-3 and compared with Korean adults. They found the mean RNFL thickness of the 72 normal children and adolescents was 105.53 +/- 10.33 micron. The mean values for left and right eyes were 104.28 +/- 7.68 micron and 106.79 +/- 12.98 micron, respectively. They also found there was no significant difference in mean RNFL thickness between the

4 quadrants of the left and right eyes (p=0.926). There was no significant gender difference in the mean RNFL thickness and no significant difference between children and adults in RNFL thickness (p=0.822 and p=0.08).

9. Fisher JB et al studied the relation of visual function to RNFL in MS. The study was published in ophthalmology 2006 Feb; 113(2);324-32. It is a cross sectional study. The purpose of the study is to examine the relation of visual function to retinal nerve fiber layer (RNFL) thickness as a structuralbiomarker for axonal loss in multiple sclerosis (MS), and to compare RNFL thickness among MS eyes with a history of acute optic neuritis (MS ON eyes), MS eyes without an optic neuritis history (MS non-ON eyes), and disease-free control eyes.it was done on 180 eyes of 90 patients of MS and 72 eyes of36 patients of disease free controls. RNFL was measured using optical coherence tomography with fast RNFL thickness software protocol and vision testing was performed for each eye and

binocularly before oct using low-contrast letter acuity (sloan charts, 2.5% and 1.25% contrast levels at 2 m) and contrast sensitivity (pelli-robson chart at 1 m). Visual acuity (retroilluminated early treatment diabetic retinopathy charts at 3.2 m) was also measured.Even though the snellen acuity equivalents were better than 20/20 in both groups, RNFL thickness was reduced significantly in MS patients (92 mum) versus controls (105 mum) ($p<0.001$) and more reduced in MS patients after optic neuritis (85 mum; $p<0.001$); lower visual function scores were associated with reduced average overall RNFL thickness in MS eyes; for every 1-line decrease in low-contrast letter acuity or contrast sensitivity score, the mean RNFL thickness decreased by 4 micron.They concluded that Scores for low-contrast letter acuity and contrast sensitivity correlate well with OCT-RNFL as a structural biomarker, supporting that these visual function tests as secondary clinical outcome measures for MS trials. These

results also suggest a role for ocular imaging techniques such as OCT in trials that examine neuroprotective and other disease-modifying therapies. They also concluded that axonal loss is seen in MS patients even without optic neuritis.

10. Pro MJ et al in J Neurol Sci.2006 Dec 1;250(1-2);114-9.The purpose of the study is to demonstrate whether OCT-3 and HRT-2 can be used to measure changes of the optic disc and peripapillary retinal nerve fiber layer (RNFL) in eyes with acute retrobulbar optic neuritis that have no clinically apparent optic disc swelling. To correlate these with MRI of the affected optic nerve. 8 patients of acute retrobulbar optic neuritis with no prior optic neuritis were made to undergo OCT-3, HRT-2 and MRI at presentation, 1 and 3 months after the disease. They found the affected eyes without clinically seen optic disc swelling, there was a non-significant trend to increased thickness in the total RNFL, superior and nasal measurements. Baseline HRT in

affected eyes showed smaller mean cup to disc ratio ($p=0.003$) and a smaller cup area ($p=0.002$) compared with the unaffected eye. The MRI did not correlate with OCT and HRT. Follow-up imaging of the affected eyes showed normalization of HRT cup size parameters and OCT RNFL thickness ($p<0.04$). At follow-up,the temporal RNFL had thinning in 7/8 affected eyes (46.8 mum, $p=0.021$) compared with fellow unaffected eyes (57.8 mum), which did not change. Hence RNFL imaging is useful in assessing residual injury after optic neuritis.

11. Sony P et al in Indian journal of ophthalmology 2004 Dec; 52(4); 303-9,studied the retinal nerve fibre layer thickness in normal Indian eyes with OCT-3. It is a cross sectional study. In 146 (84 males and 62 females) normal subjectsPeripapillary retinal nerve fibre layer was imaged by OCT-3. The RNFL thickness was measured in four quadrants and the data wasanalysed using SAS commercial statistical software.Using unpaired t test, one-way analysis

variance (ANOVA) and Pearson's correlation coefficient influence of age and gender was evaluated. They found that the average RNFL thickness in the population under study was 104.27 +/- 8.51 (95% CI 87.25-121).Age had a significant negative correlation with average RNFL thickness (r = -0.321, P = 0.000) and with average superior (r = -0.233, P = 0.005) and average inferior RNFL thickness (r = -0.234, P = 0.004). There was no effect of gender on various RNFL thickness parameters.

12. Trip SA et al in Ann neurol 2005 sep;589(3);383-91.They studied retinal nerve fibre layer axonal loss and visual outcome in optic neuritis. In optic neuritis to quantify axonal loss of the retinal nerve fiber layer (RNFL) and secondary retinal ganglion cell loss in the macula with optical coherence tomography. 25 patients were enrolled who had a previous single episode of optic neuritis and 15 control subjects. Optical coherence tomography measurement of RNFL thickness and macular volume,

quantitative visual testing, and electrophysiological examination were performed. There were highly significant reductions ($p < 0.001$) of RNFL thickness and macular volume in affected patient eyes compared with control eyes and clinically unaffected fellow eyes. There were significant relationships among RNFL thickness and visual acuity, visual field, color vision, and visual-evoked potential amplitude. This study has demonstrated functionally relevant changes indicative of axonal loss and retinal ganglion cell loss in the RNFL and macula, respectively, after optic neuritis.

13. Keltner JL et al studied the visual field profile of optic neuritis in Arch ophthalmol2010Mar;128(3):330-7.They evaluated visual field abnormalities after an episode of optic neuritis among participants in the Optic Neuritis Treatment Trial. They evaluated 10 443 visual fields from 454 patients and classified visual field abnormalities into 21 different monocular categories representing 3 general

types of visual loss: diffuse, localized, and artifactual. Classification frequency was determined and reader agreement was evaluated. The association of visual field abnormality classifications with mean deviation, pattern standard deviation, visual acuity, and foveal threshold was assessed. They found that diffuse loss of 66.2% in the affected eyes but only 6.2%in the fellow eyes. During years 1 through 15,both the groups exhibited predominantly localized loss in the nerve fiber bundle region (partial arcuate, paracentral, and arcuate defects). At year 1, 35.7% in the affected eyes and 34.4% in the fellow eyes consisted of localized defects. At year 15, 39.5% in the affected eyes and 26.3% in the fellow eyes consisted of localized defects. Foveal threshold was highly correlated with visual acuity and contrast sensitivity in the affected eye at baseline (-0.82 vs 0.79, respectively).

14. Costello et al 2008 showed that earliest significant difference between the two eyes were seen in temporal region 2 months after optic neuritis and thinning progressed upto 6 months and there after stabilized.

15. Cedric Lamirel MD et al studied OCT in MS and optic neuritis and they concluded that RNFL thickness in OCT may become part of routine tests to measure disease activity, follow up MS patients and effects of treatment in the future.

AIMS AND OBJECTIVES

1. To correlate the changes in OCT and visual outcome in patients with opticneuritis .

2. To evaluate the patients of optic neuritis.

3. To treat all patients with intravenous methyl prednisolone 250 mg 4 times a day for 3 days followed by oral prednisolone 1mg per kg body weight for 11 days.

4. To include OCT as a tool in the management of patients with optic neuritis.

5. To identify the patients who are all at risk for optic atrophy with the help of OCT.

MATERIALS AND METHODS

SUBJECT SELECTION

All patients attending to outpatient department with symptoms and signs of optic neuritis for the period of one year.

SAMPLE SIZE

Sample size is 25 patients.

DURATION OF STUDY

All patients are followed up for one year

PLACE OF STUDY

Regional institute of ophthalmology, Chennai.

INCLUSION CRITERIA

All patients with acute visual loss with colour desaturation and pain on ocular movements suggestive of optic neuritis.

Patients of optic neuritis with RAPD.(Relative afferent pupillary defect).

EXCLUSION CRITERIA

Patients with dense media opacity and macular disease.

Patients of traumatic optic neuropathy.

Patients with toxic optic neuropathy.

Patients who are not willing for the study.

Patients with glaucomatous cupping.

Patients with bilateral disc edema suggestive of papilledema.

METHODOLOGY:

All patients presenting to OPD with history of acute onset visual loss with pain on ocular movements and colour desaturation are registered. Complete ophthalmic examination was done to look for the presence of relative afferent pupillary defect , Field charting with help of automated perimetry, testing colour vision with the help of ishihara chart, testing contrast sensitivity with pelli-robson chart, fundus examination to rule out retro bulbar optic neuritis or optic neuritis with disc edema .

History of previous similar episodes in the same or other eye was enquired in the history. Patients who are chronic alcoholic and smoker are exempted from the study because of the risk of toxic amblyopia. History of any drug intake or nutritional diseases are asked for to exclude toxic amblyopia. In children with optic neuritis history of vaccination and any recent viral infection are asked. Known cases any intra cranial tumors and with papilledema are exempted from this study. Any history

of diabetes mellitus, hypertension and ischemic arterial disease are enquired. On general examination other systems examined, pulse, blood pressure were recorded.

On ocular examination

- visual acuity with the help of snellan's chart was recorded.
- Extra ocular movements were noted.
- Pupillary examination including size, shape,direct and consensual light reaction were noted. Relative afferent pupillary defect is elicited by swinging flash light test. Torch is shined on one eye pupil for 2-3 seconds and then rapidly shifted to other eye for 2-3 seconds. This is repeated for 4-5 times and only the direct response to light is observed. To say normal the velocity and amplitude should be symmetrical whereas light stimulation will produce sluggish response in affected eye then the pupil will redilate then the light is moved to other eye and that pupillary constriction is greater in velocity and amplitude

due increase in pupillo motor inputs. It is graded 1-4+ in ascending order and can be quantified with neural density filters.

- Anterior segment examination was done with the help of slit lamp.
- A dilated and detailed fundus examination with direct ophthalmoscope and slit lamp examination with 90 D lens.
- Refraction was done.
- Intra ocular pressure is measured with goldmann applanation tonometer.
- Colour vision tested with ishihara pseudo isochromatic plates,
- Fields recorded with octopus perimeter and
- Contrast sensitivity with pelli-robson chart.

All patients were advised to undergo blood investigation, MRI brain to rule out demyelination, MRI spine in Devic's disease, visually evoked potential, chest and para nasal sinus x-ray to rule out infectious causes, and spectral domain-scanning

laser ophthalmoscope optical coherence tomography to quantify the axonal loss after an attack of optic neuritis. Cerebrospinal fluid assay and NMO IgG assay in cases of multiple sclerosis and transverse myelitis.

Blood investigations done are total count, differential count, erythrocyte sedimentation rate, blood sugar, HIV, VDRL. Neurologist opinion sought in all cases and septic foci are eliminated after concerned specialist opinion.

All patients were treated with intravenous methyl prednisolone 250 mg four times daily for three days and followed by oral prednisolone 1mg per kilogram body weight for eleven days (according to ONTT).

Visual acuity, colour vision, fields, contrast sensitivity were tested and fundus examination, pupillary assessment done after treatment and second weekly for one month and then at 3months and 6months.

SD OCT-SLO was done on all patients at the end of 4weeks or after the resolution of disc edema. Retinal nerve fiber layer thickness assessment made and correlated with visual outcome.

All patients were followed up for the study period of one year. Visual acuity, Colour vision, Fields, Contrast sensitivity, Pupillary assessment, Fundus examination, Refraction were done during follow up.

RESULTS

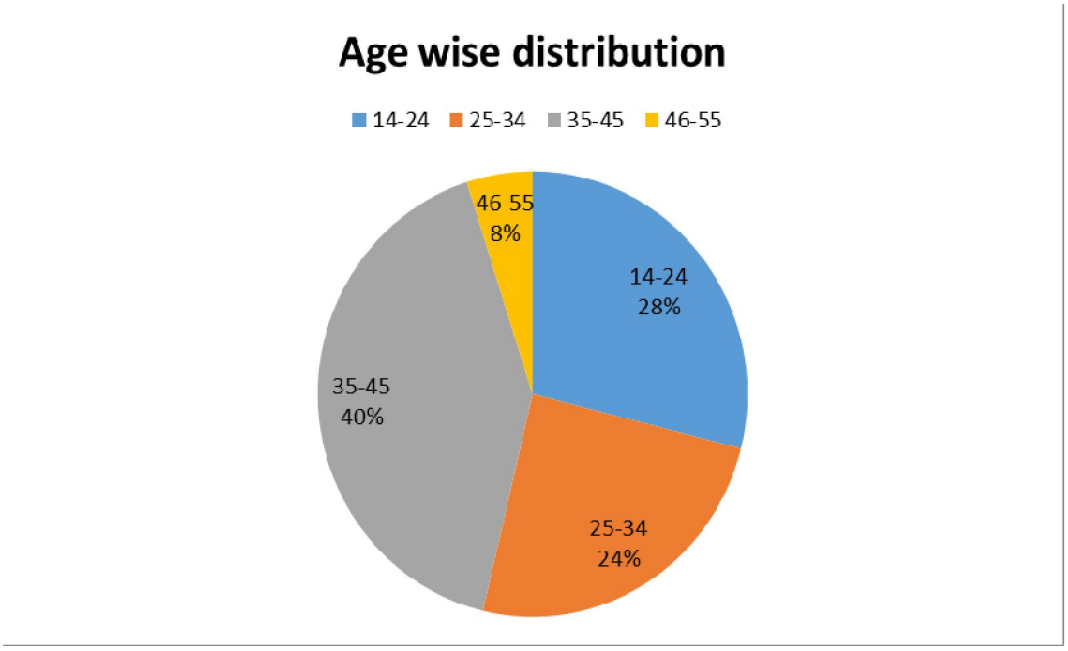
AGE DISTRIBUTION

TABLE-1:AGE WISE DISTRIBUTION

Age	Total number of patients	Percentage
14-24	7	28%
25-34	6	24%
35-45	10	40%
46-55	2	8%
Total	25	100%

In our study 40% of them were in 35-45 years of age, 28% were in 14-24 years of Age, among them only one patient was below 15 years all others were above 18 years. 24% were in 25-34 years of age. Only 8% were in the age group above 46 years.

GRAPH-1(Age distribution)



In our study majority of patients were in the age group of 18 to 35 years, only one Patient was below 15 years, the diseases was only 8% in those Individual above 45 years of age. It is 40% in 35-45 years group. So we found that the disease is more common between 20-45 years.

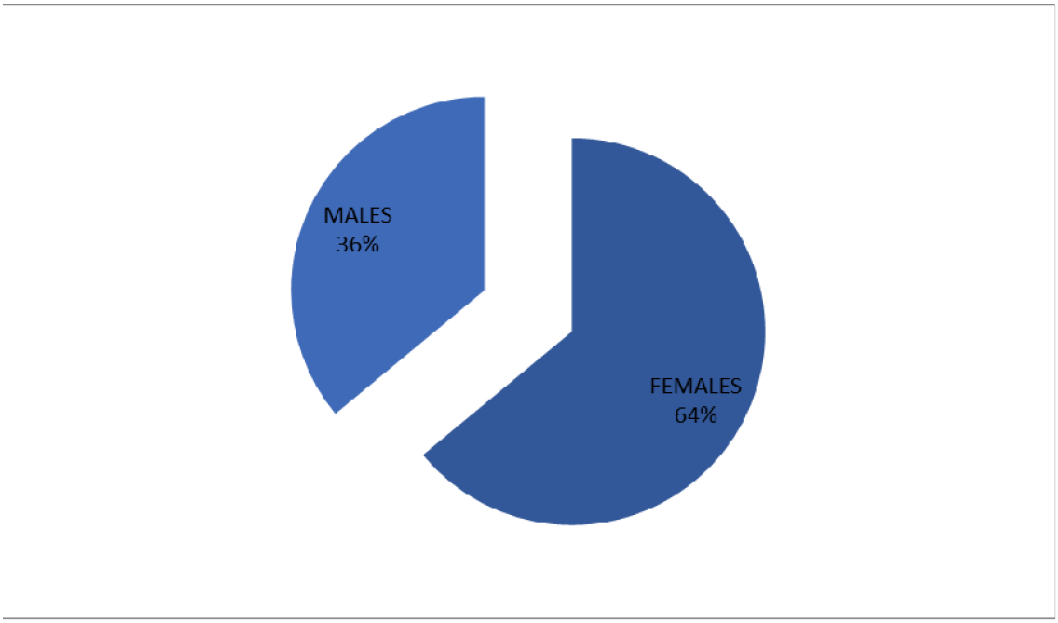
SEX DISTRIBUTION

TABLE-2 (SEX DISTRIBUTION)

Sex	Number of patients	Percentage
Males	9	36%
Females	16	64%
Total	25	100%

In our study, females out -numbered males by 28%, that is 64% of patients in our study are females whereas males are only 36%. From this table above we conclude that the disease is more common among females.

GRAPH 2: SEX DISTRIBUTION



Hence in our study there was a significant gender difference.

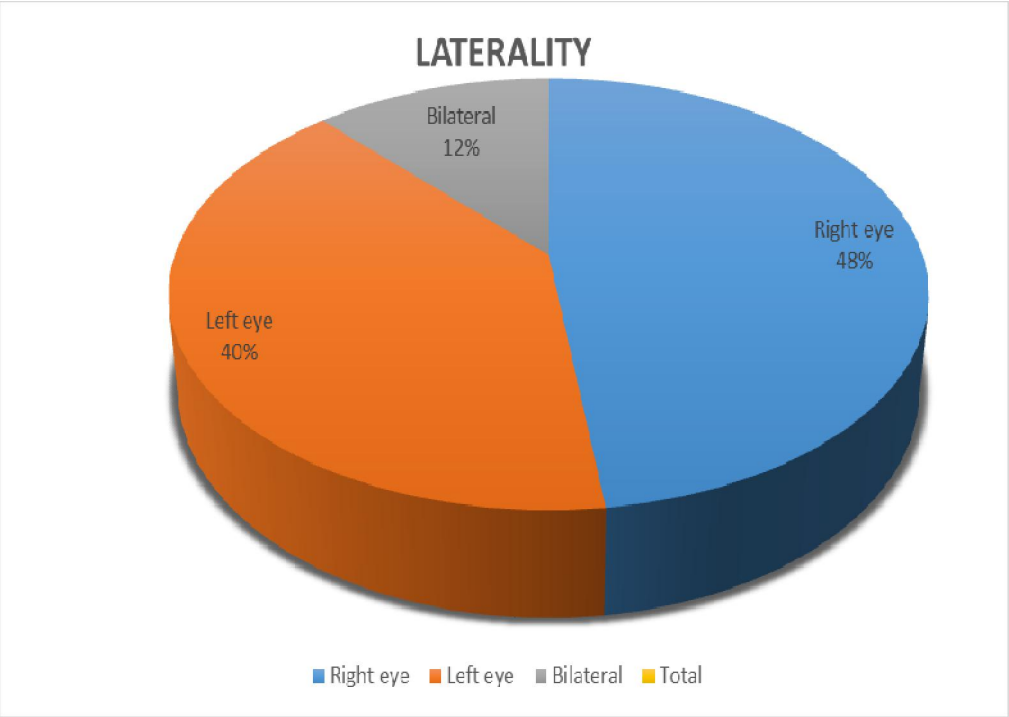
LATERALITY

TABLE-3 (LATERALITY)

Laterality	Total number	Percentage
Right eye	12	48%
Left eye	10	40%
Bilateral	3	12%`
Total	25	100%

In this study, right eye was affected in the majority of patients. 12 patients out of 25 study group (48%)presented with right sided optic neuritis. 10 out of 25 patients presented with left sided optic neuritis (40%). Three patients developed optic neuritis in other eye during the study period (12%).

GRAPH-3 (LATERALITY)



In our study 48% of individual had disease in right eye, 40%had disease in left eye and in 12% of individual both the eyes were affected during the study period.

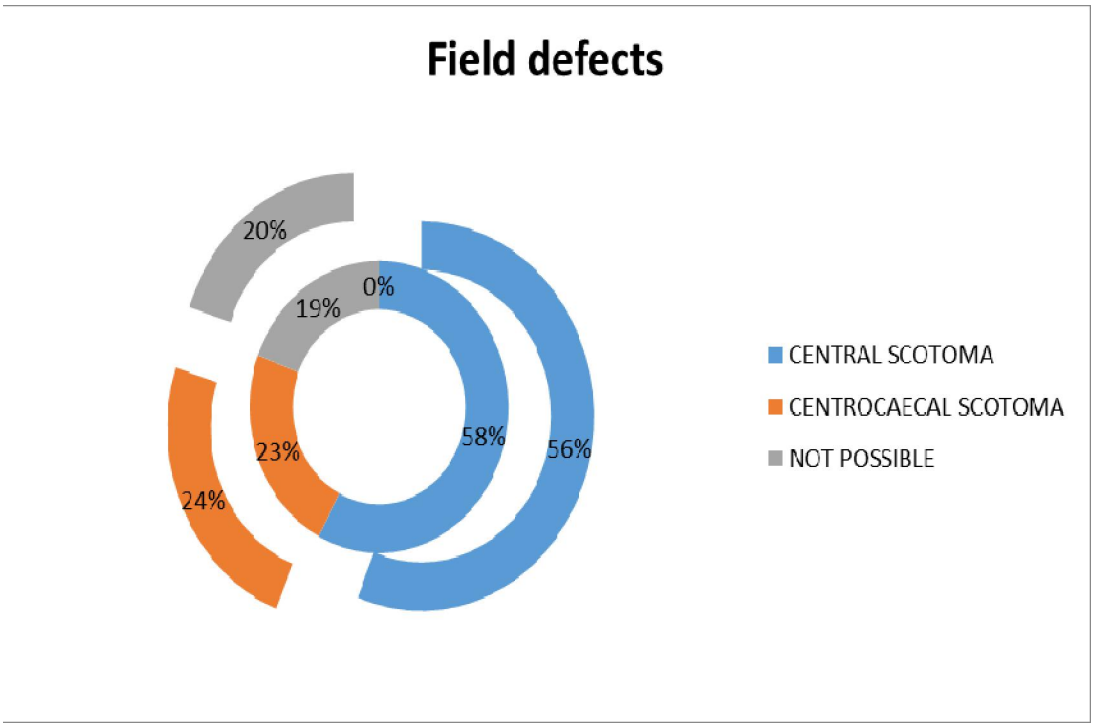
FIELD DEFECTS

TABLE-4 (FIELD DEFECTS)

Field defects	Number of patients	Percentage
Central scotoma	14	56%
Centrocaecal scotoma	6	24%
Not possible	5	20%

14 Patients (56%) out of 25 were presented with central scotoma whereas 6 were (24%)Presented with centrocaecal scotoma, and in 5 patients assessment of fields was not possible because of poor vision (worse than 1/60). We found that most patients with optic neuritis presented with central scotoma.

GRAPH -4 (FIELD DEFECT)



So according to our study the most common field defect was central scotoma. Next is centero cecal scotoma.

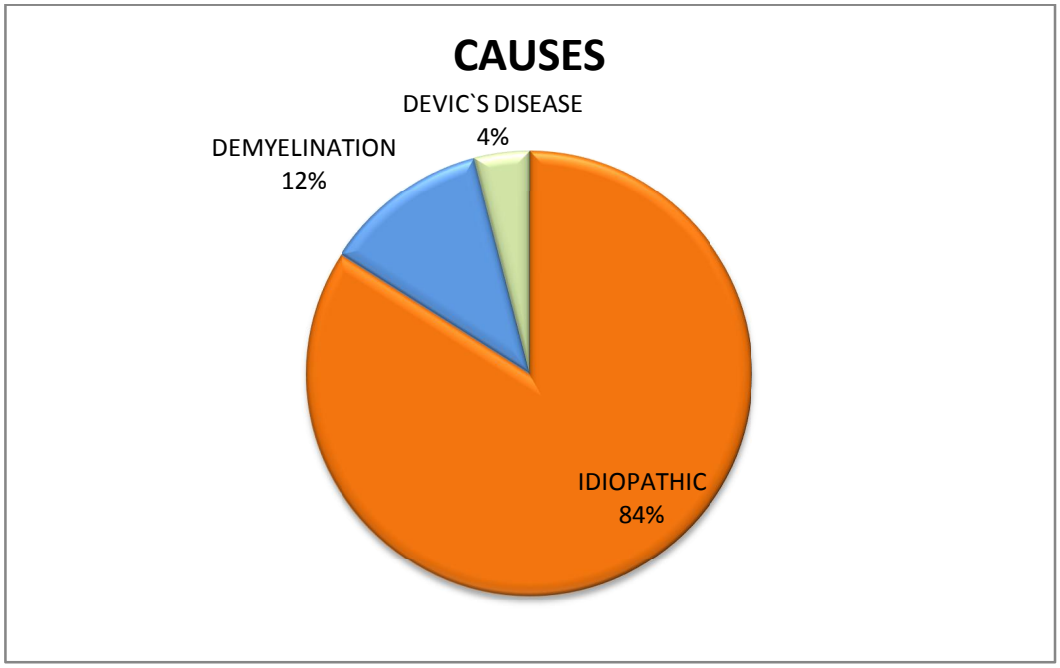
CAUSES OF OPTIC NEURITIS

In our study the most common cause being idiopathic, only 3 patients out of 25 showed demyelination plaques (12%) suggestive of multiple sclerosis in MRI brain. Only one patient (4%) was positive for MRI brain and MRI spinal cord with NMO-IgG positivity suggestive of devic's disease.

TABLE-5 (CAUSES OF OPTIC NEURITIS)

Causes	Number of patients	Percentage
Idiopathic	21	84%
Multiple sclerosis	3	12%
Devic's disease	1	4%

GRAPH-5(CAUSES)



In our study we found that the most common cause for optic neuritis was idiopathic in nature.

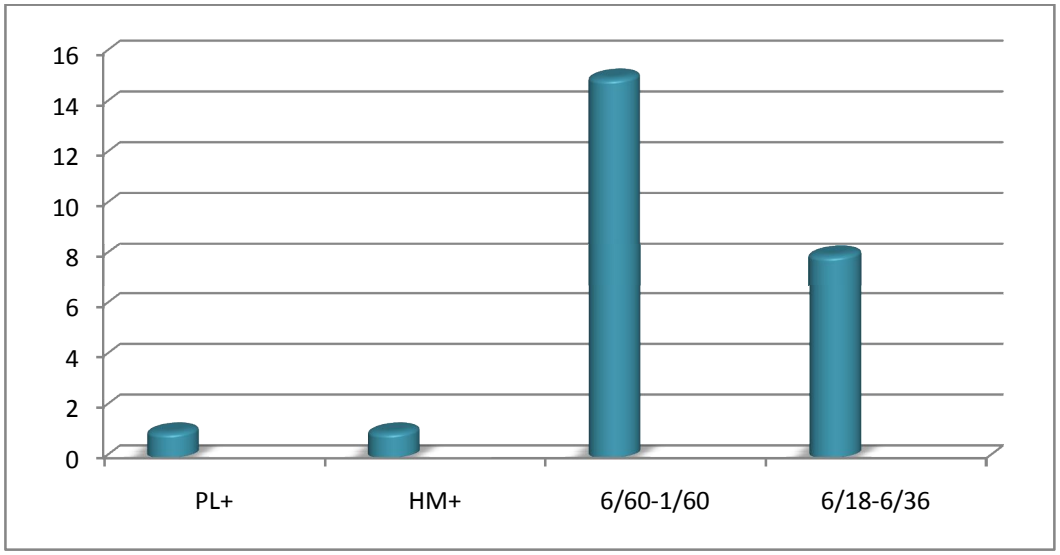
VISUAL ACUITY AT PRESENTATION

TABLE-6(VISUAL ACUITY AT PRESENTATION)

VISUAL ACUITY ATPRESENTATION	TOTAL NUMBER OFPATIENTS	PERCENTAGE
Perception of light +/-	1	4%
Hand movements +	1	4%
6/60-1/60	15	60%
6/18-6/36	8	32%
Total	**25**	**100%**

In our study majority of patient's (15) visual acuity at the time of presentation was between 6/60-1/60 by snellen's chart, 8 patients had visual acuity of 6/18-6/36. Only one patient presented with hand movement and one patient with no perception of light. From this table we found that the visual loss in optic neuritis can vary from 6/18 to no PL.

GRAPH-6(VISUAL ACUITY AT PRESENTATION)



In our study 60% of patients were presented to our department with visual acuity of 6/60-1/60, 32% were presented with the visual acuity of 6/18-6/36 and 4% of them had visual acuity of HM+ or NO PL at presentation. So we found that the visual acuity in optic neuritis can range from 6/18 to No PL.

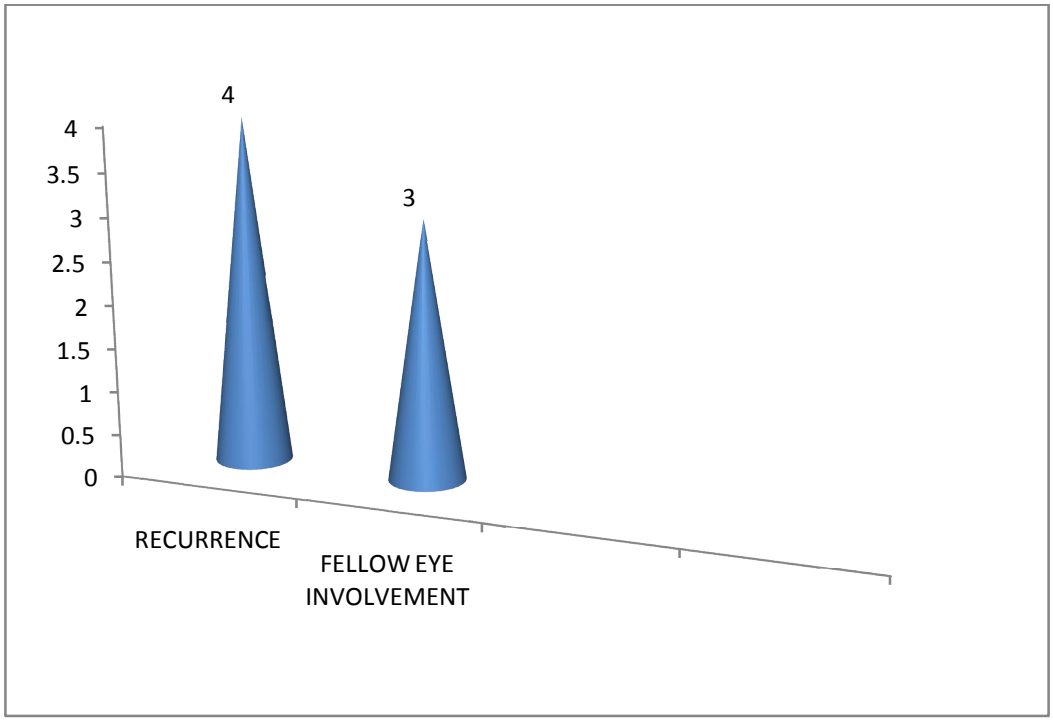
RECURRENCE RATE

In our study 4 patients had recurrence during study period. Out of the 4, one is a case of devic's disease, one showed demyelination plaque in MRI brain suggestive of multiple sclerosis and the other two with no associated risk factor.During our study period 3 patients developed optic neuritis in felloweye, all had no associated risk factor.

TABLE-7(RECURRENCE OF OPTIC NEURITIS)

Factors associated with recurrence of disease	Number of patients	Percentage
Multiple sclerosis	1	25%
Devic's disease	1	25%
No other associated factors	2	50%
Total	4	100%

GRAPH-7 (RECURRENCE RATE)

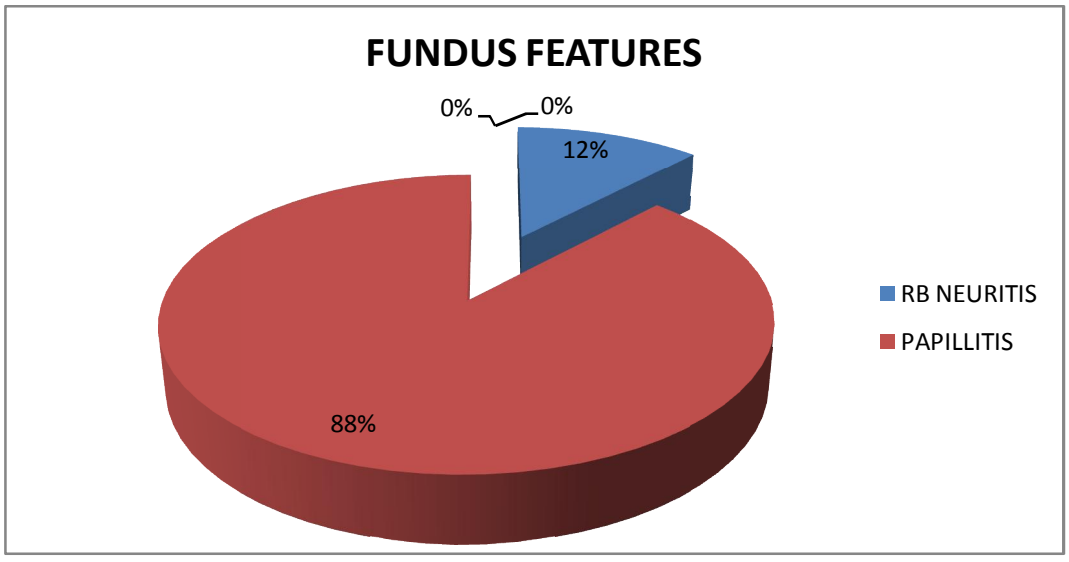


In our study and from the above charts we found that there was no associated risk factors involved with recurrence in the same eye or the involvement of fellow eye during the study period.

FUNDUS FEATURES

In our study only three patients were presented with retrobulbar neuritis whereas all other patients had disc edema and blurring of disc margin. Six patients developed disc pallor during recovery after treatment.

GRAPH 8- FUNDUS FEATURES



RETINAL NERVE FIBER LAYER THICKNESS IN OPTICAL COHERENCE TOMOGRAPHY

ANALYSIS – UNPAIRED T TEST

Descriptive Statistics, Table-8(RNFL thickness in OCT)

RNFL THICKNESS	Number of individual	Minimum	Maximum	Mean	Std. Deviation
RNFL – FELLOW EYE	25	81	156	122.32	20.012

Descriptive Statistics, Table-9(RNFL thickness in OCT)

RNFL THICKNESS	Number of individual	Minimum	Maximum	Mean	Std. Deviation
RNFL – AFFECTED EYE	25	67	140	97.48	19.822

RNFL THICKNESS	Number of individual	Mean	Std. Deviation	SEM
RNFL – FELLOW EYE	25	122.3	20.01	4.002
RNFL – AFFECTED EYE	25	97.48	19.82	3.964

Difference	24.84	5.633

95% confidence interval for difference: 13.51 to 36.17.t = 4.410 (VALUE) with 48 degrees of freedom; **P = 0.0001 – HIGHLY SIGNIFICANT** . NULL HYPOTHESIS IS REJECTED AT P VALUE 0.0001

RNFL – THINNING OCCURS IN OPTIC NEURITIS OF THE AFFECTED EYE THAN THE FELLOW EYE.

TREATMENT GIVEN

All patients were treated with intravenous methyl prednisolone 250 mg four times daily after assessment of general condition of them.

It was followed by oral prednisolone 1 mg per kilogram body weight for eleven days.

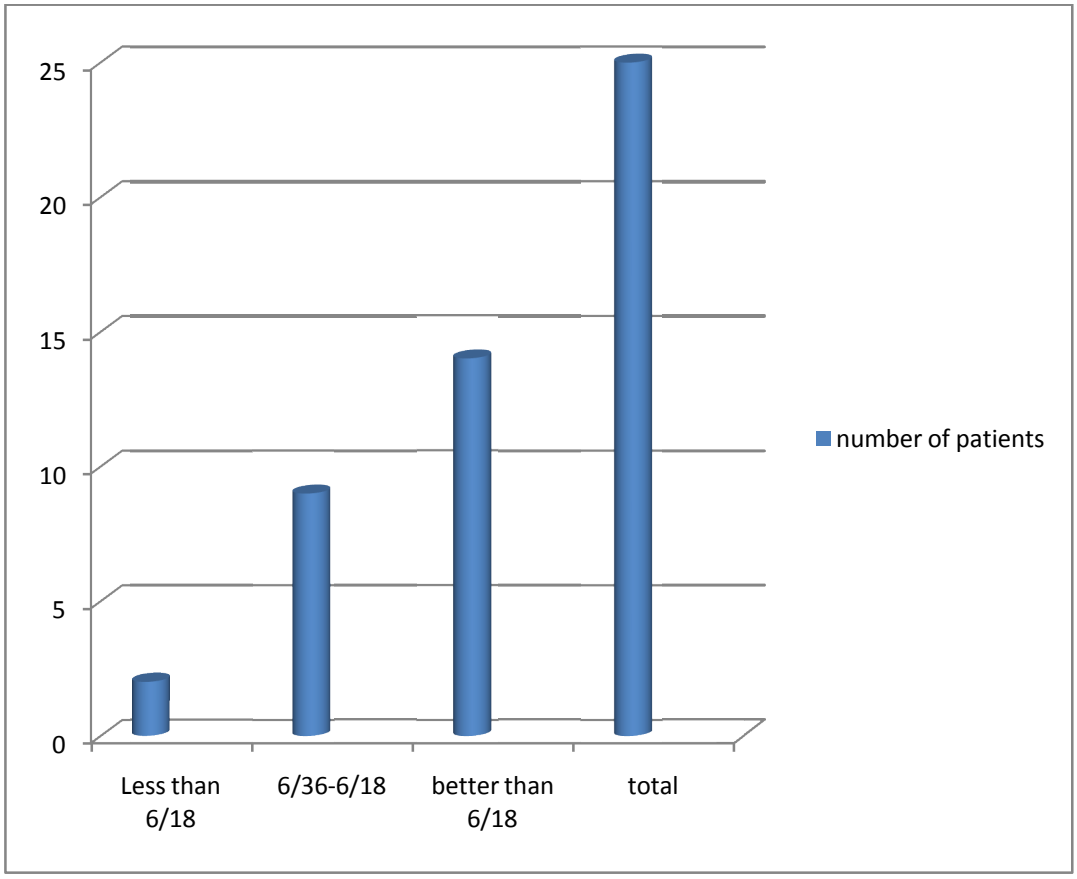
VISUAL ACUITY AFTER TREATMENT

TABLE- 10(Visual acuity after treatment)

Visual acuity	Number of patients	Percentage
Less than 6/36	2	8%
6/36-6/18	9	36%
Better than 6/18	14	56%
Total	25	100%

All patients in our study had good visual acuity after treatment. Out of 11 patients Who showed less improvement after treatment, 6 developed optic atrophy during the study period and 5 had lens changes but through which fundus examination was possible. We found that patient who had more RNFL thinning showed less gain in post treatment visual acuity.

GRAPH 9 (VISUAL ACUITY AFTER TREATMENT)



After treatment with ONTT regimen 56% had visual acuity better than 6/18,that is they all improved upto 6/9 and 6/6. Six patients developed disc pallor after optic neuritis.

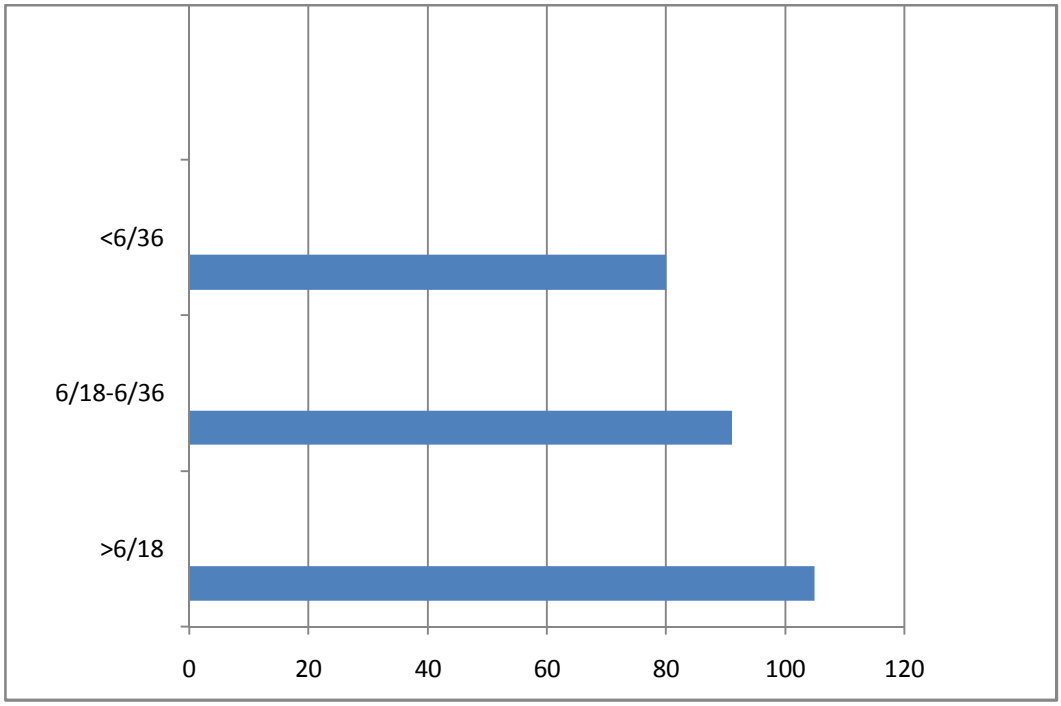
CORRELATION OF RNFL THICKNESS WITH VISUAL OUTCOME

In our study if the difference in retinal nerve fibre layer thickness between The two eyes is more than 25 microns, it is found that the recovery of vision is poor after treatment. We also found that the thinning is more marked in patients with optic atrophy. In patients who recovered well after treatment, showed minimal thinning of retinal nerve fibre layer in optical coherence tomography. The thinning of retinal nerve fibre layer was more marked in the temporal quadrant in OCT in all 25 patients who underwent the study. Those who had optic atrophy showed thinning in other quadrants also.

TABLE-11 (RNFL THICKNESS WITH VISUAL OUTCOME)

Mean thickness of RNFL in microns	Visual acuity after treatment	Number of patients	Percentage
80	Worse than 6/36	3	12%
91	6/36-6/18	8	32%
104.92	Better than 6/18	14	56%

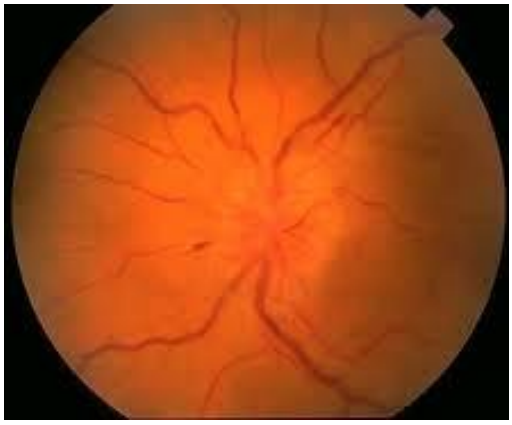
GRAPH 10: CORRELATION OF RNFL THICKNESS WITH VISUAL OUTCOME



In our study the mean retinal nerve fibre layer thickness is more than 100 microns in patients who are all improved to 6/18 or better after treatment, whereas in patients in whom the visual acuity was worse than 6/36 after treatment the RNFL thickness was 80 microns. Hence from our study those with marked thinning of RNFL show less improvement in vision after treatment.

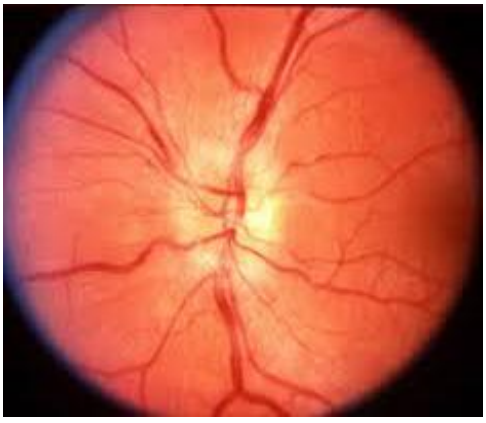
Colour Plate 1

Fundus Picture of Patient 6



Colour Plate 2

Fundus Picture of Patient 10



Colour Plate 3

Fundus Picture of Patient 15

Colour Plate 4

Fundus Picture of Patient 18

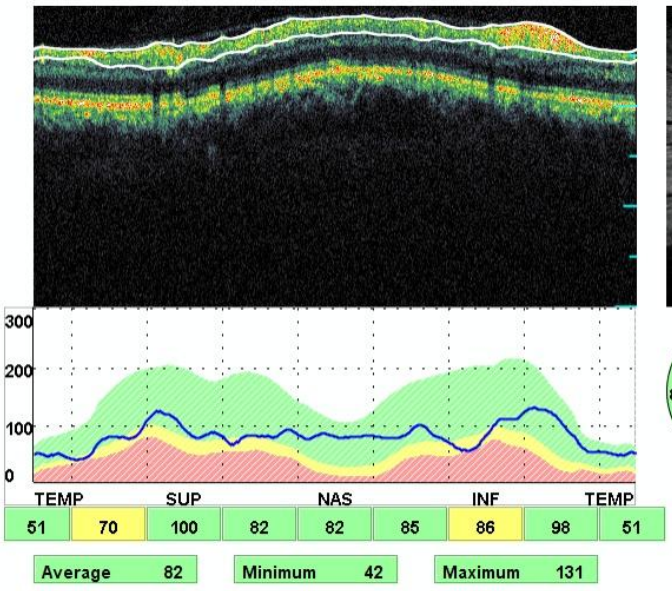
Colour Plate 5

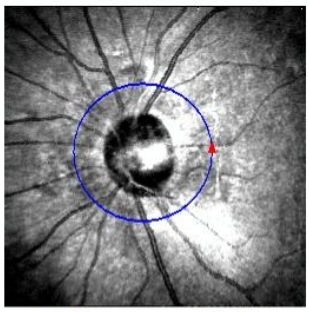
OCT Picture of Patient 5 - LE

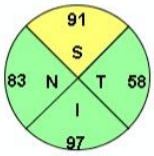
RIO-GOH ,EGMORE,CHENNAI

Patient Name: KUMAR, K
Patient ID: 872/14 OPT
Description: **OS**

D.O.B.: Jan 1, 1970
Date: May 26, 2014







Comments:

SPECTRAL SLO OCT REPORT

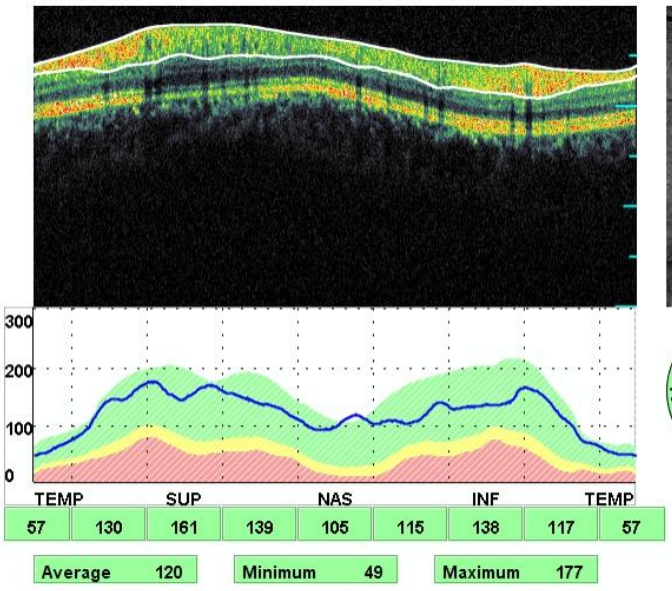
Colour Plate 6

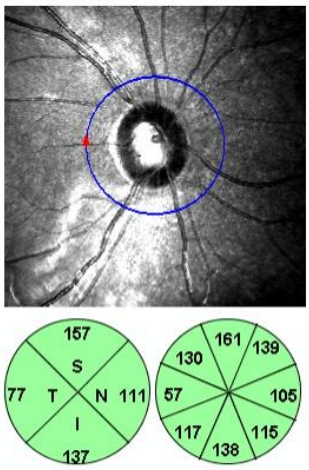
OCT Picture of Patient 10 - RE

RIO-GOH ,EGMORE,CHENNAI

Patient Name: NAGALAKSHMI, M
Patient ID: 33087/14 OPT
Description: **OD**

D.O.B.: Dec 22, 1999
Date: May 13, 2014





Comments:

SPECTRAL SLO OCT REPORT

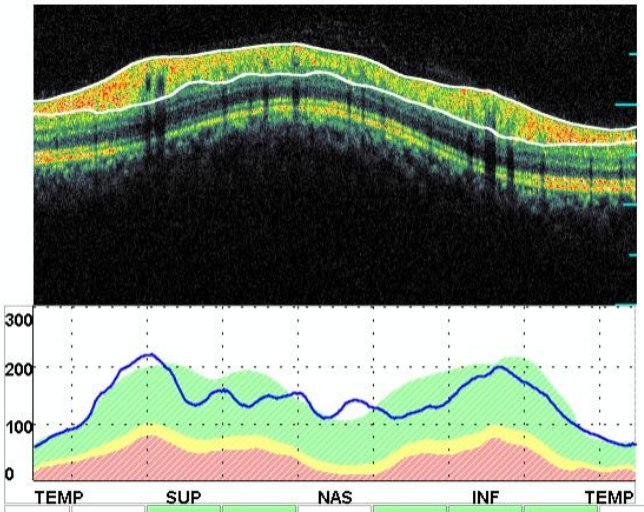
Colour Plate 7

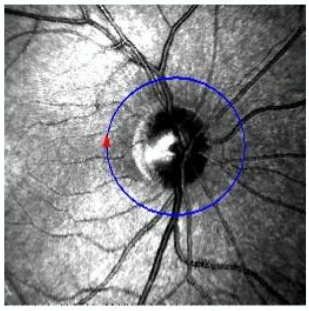
OCT Picture of Patient 2 - RE

RIO-GOH ,EGMORE,CHENNAI

Patient Name: PRIYA, G
Patient ID: 494563/14 OPR
Description: **OD**

D.O.B.: May 1, 1984
Date: Jun 2, 2014





Comments:

SPECTRAL SLO OCT REPORT

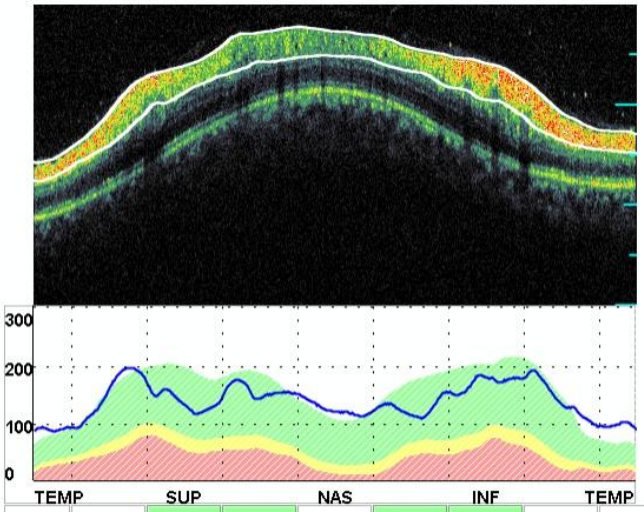
Colour Plate 8

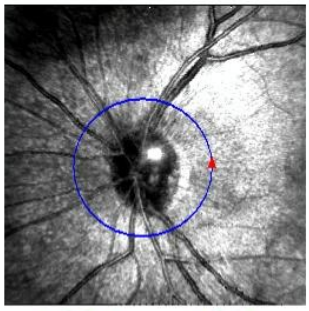
OCT Picture of Patient 2 - LE

RIO-GOH ,EGMORE,CHENNAI

Patient Name: PRIYA, G
Patient ID: 494563/14 OPR
Description: **OS**

D.O.B.: May 1, 1984
Date: Feb 3, 2014





Comments:

SPECTRAL SLO OCT REPORT

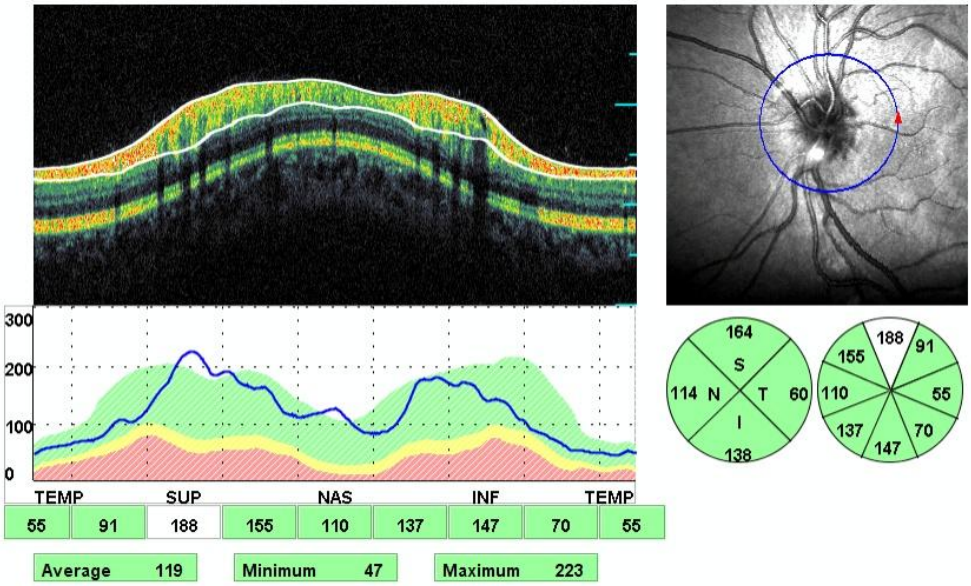
Colour Plate 9

OCT Picture of Patient 15 - LE

RIO-GOH ,EGMORE,CHENNAI

Patient Name: SRIMATHY, C
Patient ID: 497275/14 OPT
Description: **OS**

D.O.B.: Jun 13, 1995
Date: May 12, 2014



Comments:

SPECTRAL SLO OCT REPORT

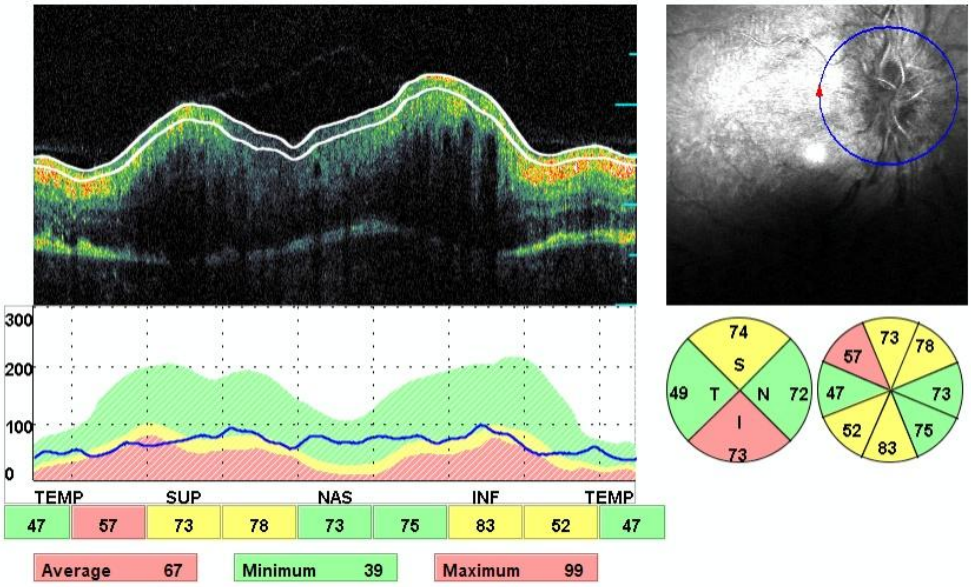
Colour Plate 10

OCT Picture of Patient 15 - RE

RIO-GOH ,EGMORE,CHENNAI

Patient Name: SRIMATHY, C
Patient ID: 497275/14 OPT
Description: **OD**

D.O.B.: Jun 13, 1995
Date: May 6, 2014



Comments:

SPECTRAL SLO OCT REPORT

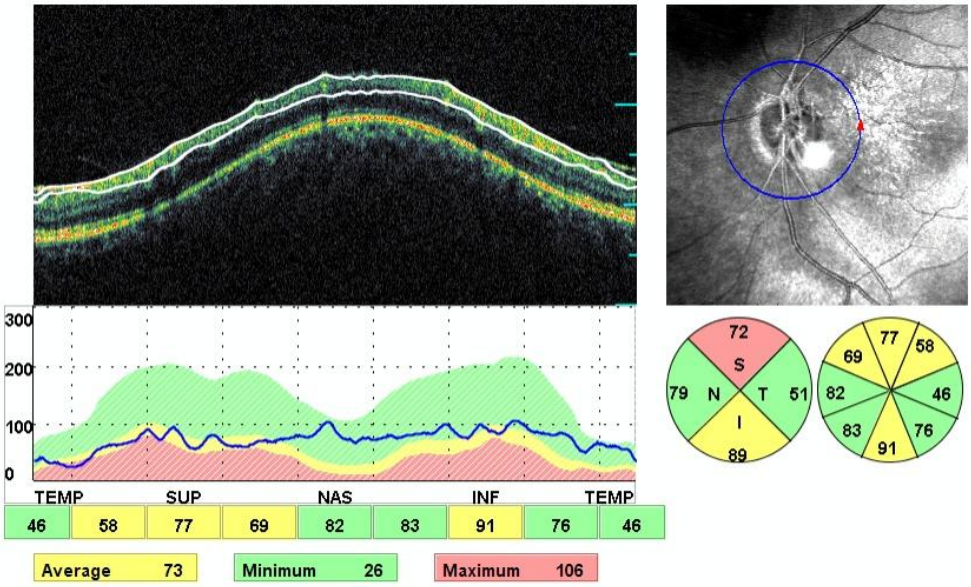
Colour Plate 11

OCT Picture of Patient 7 - LE

RIO-GOH ,EGMORE,CHENNAI

Patient Name: JAYSHANKAR, C
Patient ID: 494059/14 OPT
Description: **OS**

D.O.B.: Jan 1, 1973
Date: Feb 3, 2014



Comments:

SPECTRAL SLO OCT REPORT

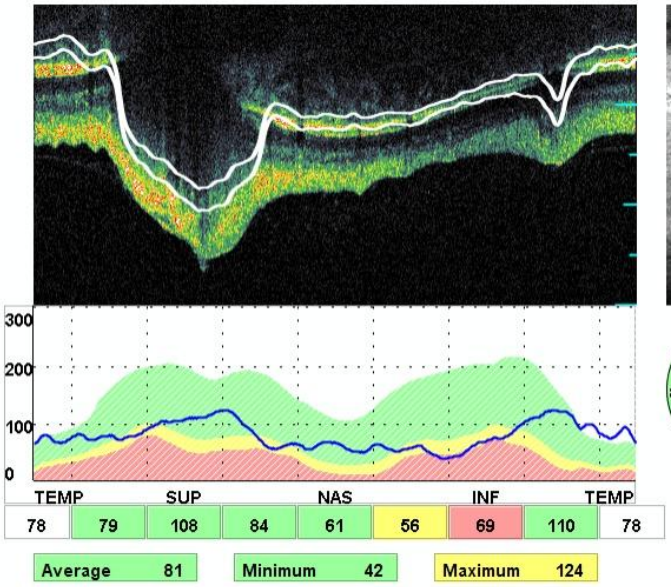
Colour Plate 12

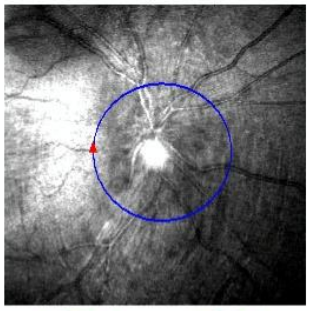
OCT Picture of Patient 7 - RE

RIO-GOH ,EGMORE,CHENNAI

Patient Name: JAYSHANKAR, C
Patient ID: 494059/14 OPT
Description: **OD**

D.O.B.: Jan 1, 1973
Date: Feb 3, 2014





Comments:

SPECTRAL SLO OCT REPORT

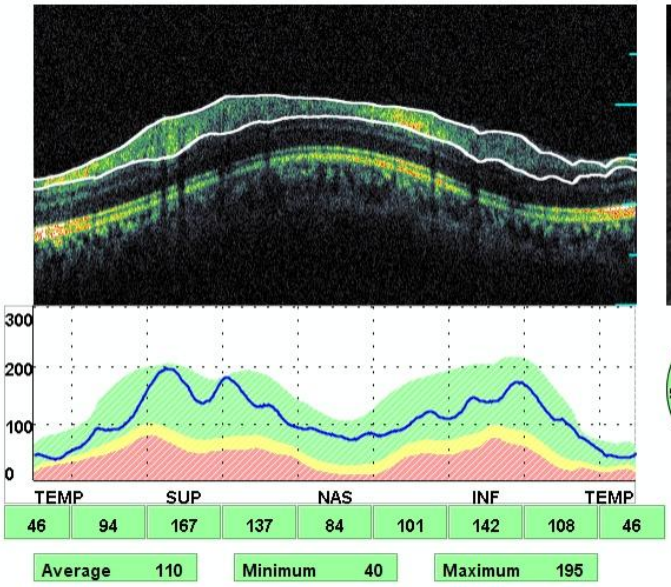
Colour Plate 13

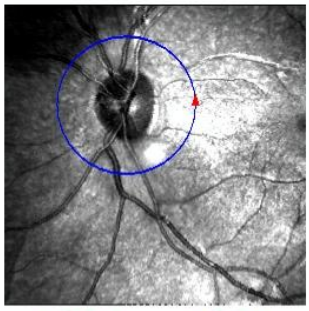
OCT Picture of Patient 4 - LE

RIO-GOH ,EGMORE,CHENNAI

Patient Name: SURESH, M
Patient ID: 494805/14 OPT
Description: **OS**

D.O.B.: May 18, 1995
Date: Feb 11, 2014





Comments:

SPECTRAL SLO OCT REPORT

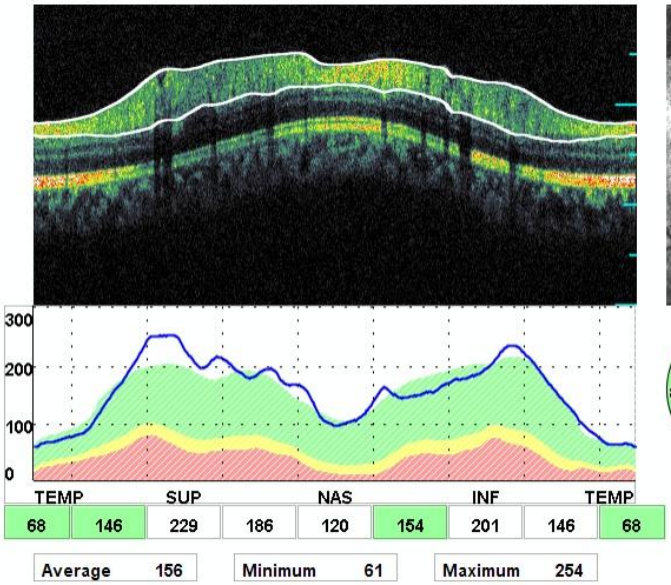
Colour Plate 14

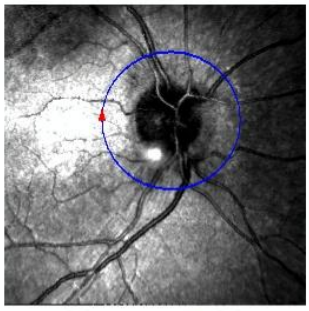
OCT Picture of Patient 4 - RE

RIO-GOH ,EGMORE,CHENNAI

Patient Name: SURESH, M
Patient ID: 494805/14 OPT
Description: **OD**

D.O.B.: May 18, 1995
Date: Feb 11, 2014





Comments:

SPECTRAL SLO OCT REPORT

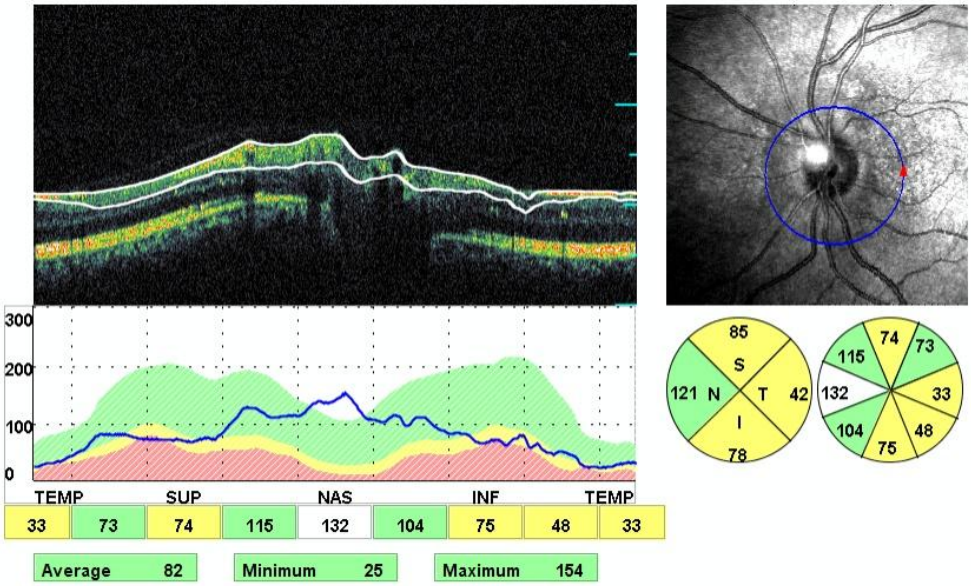
Colour Plate 15

OCT Picture of Patient 8 - LE

RIO-GOH ,EGMORE,CHENNAI

Patient Name: SOLAIAPPAN, R
Patient ID: 22437/14 OPT
Description: **OS**

D.O.B.: Aug 20, 1968
Date: May 12, 2014



Comments:

SPECTRAL SLO OCT REPORT

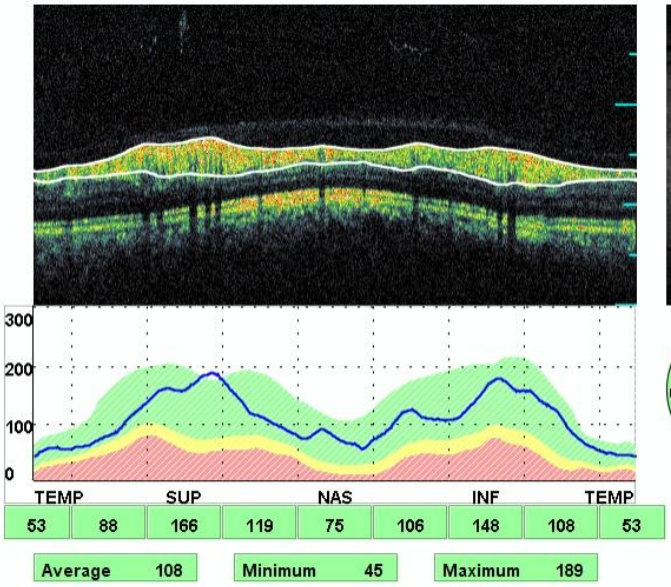
Colour Plate 16

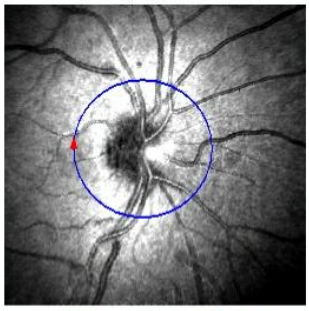
OCT Picture of Patient 8 - RE

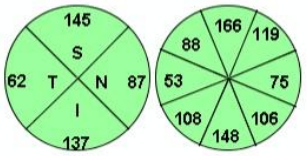
RIO-GOH ,EGMORE,CHENNAI

Patient Name: SOLAIAPPAN, R
Patient ID: 22437/14 OPT
Description: **OD**

D.O.B.: Aug 20, 1968
Date: May 12, 2014







Comments:

SPECTRAL SLO OCT REPORT

DISCUSSION

We conducted a study on the correlation of retinal fibre layer thickness in optical coherence tomography with visual outcome in optic neuritis. It is a prospective clinical study done on 25 patients in the regional institute of ophthalmology, Chennai. All patients were followed up for one year. All patients were made to undergo optical coherence tomography after the resolution of disc edema.

In our study we found that the disease was more common among (40%) 35-45 years of age and least common among 46-55(8%) years of age. Only one patient presented at the age of 14 years. 12 patients were in the age group of 15-34 years. So from our study we found that optic neuritis is more common in 18-45 years of age and we also found that optic neuritis is least likely in patients above 45 years. J Terrence et al[39] in 1991, Arch ophthalmol on clinical profile of optic neuritis found that the mean age was 31.8 years.

In this study we found that 64% of patients are females and 36% are males, out of 25 patients 16 of them are females and 9 of them are males. So the disease optic neuritis affects females commonly than males. J Terrence et al[39] found in his study on clinical profile of optic neuritis that 77.2% are females and females out-numbered males.

In our study we found that right eye is affected more than left eye, the disease is bilateral in 12% of individual. Out of 25 subjects in this study 12 patients had disease in right eye (48%) and 10 patients had disease in left eye (40%). It is not a significant difference. 3 patients out of 25 developed disease in the fellow eye during the study(12%).

This study revealed that the common field defect associated with optic neuritis is central and centrocaecal scotoma. Among the 25 patients 14 (56%) had central scotoma and 6patients(24%) developed centrocaecal scotoma. Keltner JL et al[38] in 2010 evaluated field abnormality in 454 patients of

optic neuritis and they found diffuse loss in 66.2% in affected eye and 6.2% in fellow eye.

Regarding the causes for the inflammation in optic neuritis, we found in our study that 21 patients out of 25 cases no obvious cause was found and it is said to be idiopathic. 3 patients (12%) in this study showed demyelination plaque in MRI brain suggestive of multiple sclerosis. And in our study there was only one had positive lesion in both brain and spine MRI and the patient was also positive for NMO-IgG antibody suggestive of devic's disease. We also found that the disease is bilateral in this patient and ended with optic atrophy. H Wang JM et al[40] that optic neuritis is bilateral in pediatric population. Pirko.I et al found that patients with NMO positivity has worse visual outcome. Wang JC et al[41] in his study found that in 83.9% there was no etiology for the inflammation of optic nerve.

In our study majority of patients were presented with the visual acuity of 6/60-1/60. In this study 60% (15 patients) presented with 6/60-1/60 snellen acuity, 32%(8 patients) presented with 6/18-6/36. One patient presented with hand movements only and the other patient with no perception of light.

In this study after an attack of optic neuritis 4 patients had recurrence in the same eye during the study period. Among the 4 patients one is a case of multiple sclerosis , one is positive for spine and brain MRI suggestive of devic's disease. Other two had no associated risk factor.

Fundus examination of 25 study patients revealed that 88%(22 patients) had disc edema at presentation. Only 3 patients presented with normal appearing fundus with defective vision and RAPD. 6 patients developed disc pallor during the study period. J Terrence coyle et al[7] in his study on clinical profile of optic neuritis found disc swelling in only 35.3% and normal appearing (Retrobulbar neuritis) in 64.7% of individual. Wang

JC et al[41] in his study concluded that17 out of 39 eyes had anterior optic neuritis.

Retinal nerve fibre layer thickness in optical coherence tomography revealed significant thinning in the affected eye when compared to fellow eye Mean RNFL thickness in affected eye was 97.48 microns and the mean RNFL thickness in the fellow eye was 122.32 microns. This is analysed with unpaired t test and the p-value is p=0.0001 which is highly significant, Null hypothesis is rejected at p-value, hence our study showed significant RNFL thinning in affected eye. Michael J Proa et al showed temporal RNFL thinning was found in 7 out of 8 affected eye and no change in the fellow eye. Pro MJ et al showed that OCT-3 and HRT demonstrate temporal thinning after retrobulbar neuritis even though vision improves. Trip SA Schlottman et al[7] in 2005 showed significant RNFL thinning in affected eye compared to fellow eye.

All our patients in this study were treated with intra venous methyl prednisolone 250mg four times daily for three days followed by oral prednisolone 1mg per kg body wt for 11 days (As per ONTT guidelines). Majority of patients showed good gain (better than 6/18)in visual acuity after treatment. 11 patients showed visual acuity worse than 6/18 in Snellen chart. Visual acuity was very poor (after treatment) in only 2 patients. We found that poor gain in visual acuity after treatment was due to optic atrophy, lens changes and marked RNFL thinning. Wang Jc et al[41] in 2001 found that 83.9%had 6/12 or better with tratement and 38.7% had 6/6 vision after treatment.

We found that those who had mean RNFL thickness of 80-90 microns showed less improvement even after treatment. Whereas mean RNFL thickness in those who gained vision of 6/18 or better had 104.92microns. Costello F et al[33] in 2006 found that the average RNFL 78 microns in affected eye where

as 100 microns in un affected eye and more thinning was noted in patients with impaired vision. Fisher JB et al also found that the mean RNFL in MS patients with optic neuritis was 85 microns and poor vision was associated with reduced thickness in affected eye. Trip SA et al[37] also found a significant relationship of RNFL thickness and visual acuity in optic neuritis patients.

CONCLUSION

The aim of our study was to correlate visual function with the retinal nerve fibre layer thickness in optical coherence tomography.

By analysing the results after one year follow up of optic neuritis patients the following conclusions are drawn

1. Optic neuritis has high incidence in the age group of 18-45 years in our study.

2. Females were more commonly affected than males.

3. There is a predominance of involvement of right eye over left eye in our study.

4. The most common field defect in our study on patients of optic neuritis was central and centrocaecal scotoma.

5. In our study the most common cause being idiopathic(84%), The cause in 12% of patients were multiple sclerosis and 4%(one patient)was devics's disease.

6. 60% of patients were presented with visual acuity of 6/60-1/60 and 32% were presented with the visual acuity of 6/18-6/36.

7. In our study the recurrence rate was16% and the involvement of fellow eye was 12%.

8. In our study 88% of patients were presented with disc edema and 12% with retrobulbar neuritis.

9. The mean RNFL thickness was 122.32 microns in unaffected fellow eye and the mean RNFL thickness was 97.48 microns in affected eye. The p-value was 0.0001,by unpaired t test and found to be very significant.

10. 56% improved better than 6/18 after ONTT regimen in this study and 36% improved to 6/36-6/18. In 8% the post treatment vision was worse than 6/36 in Snellen chart.

11. We found in our study that those patients whose RNFL thickness was below 90 microns gained less vision after treatment with ONTT regimen.

So we conclude from our study that there is thinning of retinal nerve fibre layer due to axonal loss after an episode of optic neuritis in all patients and the thinning is more marked in those who showed less improvement in vision after treatment.

SUMMARY

We had done this study to correlate the with RNFL thickness with visual acuity of patients after an attack of optic neuritis.

All patients who presented to our OPD with acute unilateral painful visual loss, colour desaturation and RAPD with fundus features suggestive of optic neuritis were treated with IV methyl prednisolone followed by oral prednisolone after investigations and neurologist opinion.

OCT-SLO was done on all patients after disc edema stabilizes. The RNFL thickness measured and compared with the fellow eye.

It is found that there is thinning of RNFL in all patients on affected side when compared to unaffected fellow eye. We also

found that the thinning was more marked in those who improved less with treatment and in optic atrophy.

Hence OCT can be used as a tool in patients with optic neuritis to quantify axonal loss after an attack of optic neuritis.

PROFORMA

NAME :

AGE/SEX :

I.P NO :

CHIEF COMPLAINTS: Nature of defective vision, its duration, any associated pain with ocular movements.

PREVIOUS MEDICAL HISTORY : Of similar episode.

PRIOR TREATMENT TAKEN : History of any drug intake or Nutritional deficiency.

PERSONAL HISTORY : Alcohol or Tobacco.

VISUAL ACUITY AT THE TIME OF EXAMINATION :

RE :

LE :

EXAMINATION :

RE **LE**

LIDS :

CONJUNCTIVA :

CORNEA :

PUPIL :

DIRECT :

INDIRECT :

NEAR REFLEX :

SWINGING FLASH LIGHT TEST : To detect RAPD**.**

IRIS :

ANTERIOR CHAMBER :

LENS :

FUNDUS AND VITREOUS :

TENSION : By applanation tonometry.

REFRACTION:

INVESTIGATIONS :

- Colourvision : with ISHIARA PLATES.
- Contrast sensitivity : with PELLI ROBSON CHART.
- Fields : With BJERRUMS SCREEN and with OCTOPUS automated perimetry..
- Optical coherence tomography :with Spectral domain OCT-SLO.
- MRI-Brain and optic nerve.

- BLOOD :Total count, Differential count, ESR, Mx, Chest x-ray, Blood sugar, X-ray PNS, Hemoglobin, VDRL, HIV.
- Neurologist opinion and VEP.

TREATMENT:

With ONTT regimen.

Follow up

Every patient was asked for regular follow up after 2wks, 4wks &after three months. At each visit the status of the anterior segment, fundus & visual acuity was checked and recorded in all the patients. The other eye is also considered high risk& periodically examined.

Follow up Procedures / Visits: 2 weeks, 4 weeks and 3 months

Assessments of Parameters :

- improvement invisual acuity
- Improvement in colour vision
- Improvement in visual fields
- Improvement in contrast sensitivity
- Fundus examination to look for reduction in disc edema
- Spectral domain OCT-SLO to look for RNFL thickness.

KEY TO MASTER CHART

M	-	MALE
F	-	FEMALE
RE	-	RIGHT EYE
LE	-	LEFT EYE
PH	-	PIN HOLE
NIP	-	NO IMPROVEMENT WITH PIN HOLE
RAPD	-	RELATIVE AFFERENT PUPILLARY DEFECT
DEF	-	DEFECTIVE
NP	-	NOT POSSIBLE
CS	-	CENTRAL SCOTOMA
CCS	-	CENTRO CAECAL SCOTOMA
RNFL	-	RETINAL NERVE FIBRE LAYER THICKNESS
V/A	-	VISUAL ACUITY

S.no	Name	Age	Sex	Laterality	MRD no	V/A at presentation	Pupil	Colour vision	Fields	Fundus	RNFL thickness		V/A afer 2 weeks
											Affected eye	Fellow eye	
1	Sekar	42	M	LE	494206	2/60 NIP	RAPD	DEF	CS	ABNORMAL	80	110	6/36 NIP
2	Priya	29	F	LE	494563	3/60 PH 6/36	RAPD	DEF	CS	ABNORMAL	126	138	6/9 PH 6/6
3	Visalakshi	30	M	RE	495108	6/18 NIP	RAPD	DEF	CS	ABNORMAL	100	112	6/6
4	Suresh	18	M	LE	494805	3/60 NIP	ILLSUSTAINED	DEF	CS	NORMAL	110	156	6/36 NIP
5	Kumar	44	F	LE	494872	6/60 PH 6/36	RAPD	DEF	CS	ABNORMAL	82	112	6/36 NIP
6	Salma	23	M	RE	495304	3/60 PH 6/36	RAPD	DEF	CS	ABNORMAL	100	126	6/18 PH 6/9
7	Jaishankar	49	M	LE	494861	6/24 NIP	RAPD	DEF	CS	ABNORMAL	73	81	6/60 NIP
8	Solaiappan	45	F	LE	422437	6/60 PH 6/24	RAPD	DEF	CCS	ABNORMAL	82	108	6/24 NIP
9	Vallimmal	40	F	LE	495987	6/60 PH 6/36	RAPD	DEF	CS	ABNORMAL	108	144	6/36 PH 6/18
10	Nagalakshmi	14	F	RE	495434	1/60 NIP	ILLSUSTAINED	NP	NP	ABNORMAL	85	140	6/60 NIP
11	Vimalraj	19	M	RE	436720	1/60 NIP	RAPD	NP	NP	NORMAL	82	113	6/60 NIP
12	Thangam	24	F	RE	437309	6/36 PH 6/18	RAPD	DEF	CS	ABNORMAL	100	110	6/9 PH 6/6
13	Anjalai	50	F	RE	499983	1/60 NIP	RAPD	NP	NP	ABNORMAL	127	156	6/12 PH 6/9
14	Veerammal	45	F	LE	487865	3/60 NIP	RAPD	DEF	CCS	ABNORMAL	80	110	6/24 NIP
15	Srimathi	19	F	RE	478611	3/60 PH 6/60	ILLSUSTAINED	DEF	CS	ABNORMAL	67	119	6/12 NIP
16	Devika	30	F	LE	496063	6/18 NIP	RAPD	DEF	CS	ABNORMAL	110	126	6/6
17	Rathnam	37	F	RE	455721	6/36 NIP	RAPD	DEF	CS	NORMAL	86	110	6/9 PH 6/6
18	Ramakrishnan	19	M	LE	494637	NO PL	ILLSUSTAINED	NP	NP	ABNORMAL	86	113	6/24 PH 6/9
19	Valli	30	F	LE	496404	6/60 NIP	RAPD	DEF	CS	ABNORMAL	140	156	6/9 PH 6/6
20	Arumugam	45	M	RE	495286	3/60 NIP	RAPD	DEF	CCS	ABNORMAL	81	110	6/18 PH 6/9
21	Kalyani	45	F	RE	496621	HM+	RAPD	NP	NP	ABNORMAL	100	119	6/18 NIP
22	Dhanalaxmi	35	F	RE	496710	6/36 PH 6/18	RAPD	DEF	CCS	ABNORMAL	126	144	6/9 PH 6/6
23	Devika	28	F	LE	495756	6/36 NIP	RAPD	DEF	CS	ABNORMAL	80	91	6/9 PH 6/6
24	Velu	30	M	LE	495886	3/60 NIP	RAPD	DEF	CCS	ABNORMAL	100	110	6/36 PH 6/18
25	Pachaiammal	28	F	RE	495249	6/18 NIP	RAPD	DEF	CCS	ABNORMAL	126	144	6/9 NIP

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